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JOURNAL OF MAMMALOGY

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CLOSE OF THE AGE OF MAMMALS

BY HENRY FAIRFIELD OSBORN AND H. E. ANTHONY[1]

The Age of Reptiles is estimated at 10,000,000 years by the thickness of sedimentary rocks. When the Age of Reptiles closed, land, air, and sea were left free for the rise of the mammals. The five surviving orders of reptiles were confined to the temperate and tropical zones and were only to a limited degree mammal destroyers.

The beginning of the Age of Mammals is estimated at 3,000,000 years ago. Out of very small and primitive progenitors, monotreme, marsupial, and placental, there evolved over the entire globe—land, sea, and air—a teeming mammalian life. Mammalian perfection reached its climax at the close of Pliocene time, about 400,000 years ago. The paleontologist follows this marvelous creation with wonder and admiration, as he traces the rise and adaptive radiation of twenty-four orders, one hundred sixty-six families, three thousand genera, fifteen thousand species, and its varieties of races of mammals.

The first effort at mammalian adaptation to land conditions in early Tertiary times was a failure; it was followed by natural extinction of five orders of mammals. The second mammalian adaptation culminated in the Upper Pliocene world and included man. This perfected Mammal World gradually diminished during the First, Second, and Third Glaciation, and suffered a terrible blow during the Fourth Glaciation, which led to the elimination of many superb races of mammals, and one or more of the inferior races of man. This was an extreme climatic change in which the Holarctic reindeer was driven down to

[1] This paper has been a year in preparation under the direction of the Senior author, who also contributes the introduction. The Junior author contributes the body of the paper on the fur trade, after a year of search and correspondence.

the 40th parallel, namely, 450 miles south of its present parallel. The reindeer gradually returned to northern Maine and to northern Scandinavia.

ELIMINATION BY MAN BEGAN 400,000 YEARS AGO

We may first review the story of civilization and extinction. In the struggle for food man sought flesh and marrow with primitive weapons of stone and wood. Man at this time was probably less destructive than most of the large predatory mammals. He killed with clubs, dug pits, rolled down rocks, etc.

The demand for clothing is very ancient, also beginning 400,000 years ago, furs and leather being utilized for clothing and footwear. The demand for bone and ivory utensils is also very ancient, the first bone tools being 40,000 years old, while the use of bone and ivory in art began between 25,000 to 30,000 years ago.

Cave men first employed light from burning animal oil and fat, and they also used fats in preparing pigments for personal decoration and in art. The demand for light culminated in the elimination of the sperm whale and other Cetacea and marine Carnivora. Five thousand five hundred whales have been taken in a single season from one whaling station in the Antarctic, and more than twelve thousand whales in a single season from the American Antarctic.

Agriculture is at least 20,000 years old. It is not known how early the value of animal compounds as fertilizers was discovered, but the *coup de grace* to marine life has been given by the fertilizer industry. In oceanic life the fate of the Cetacea and of marine mammals was sealed when the trade in spermaceti and in blubber oil was succeeded by the creation of fertilizer factories, which are rapidly eliminating the Cetacea. The other fur and hide-bearing marine Carnivora should enjoy the protection which is now being given the fur-bearing seals. The strongest appeal for the preservation of the walrus and the northern seals is the conservation of the natural food supply of the Eskimo.

Agriculture on land, the legitimate clearing of land and protecting of farms and gardens has been the next cause of elimination. The ranging of cattle and sheep over great areas, destroying winter food for game—sheep ruin whole watersheds because they devour all low vegetation and the bared hillsides have nothing to hold back melting snows for a normal gradual dissipation over the summer period—the killing of game by herd tenders, bounty systems against carnivora, and indiscriminate poisoning campaigns are all factors in the elimina-

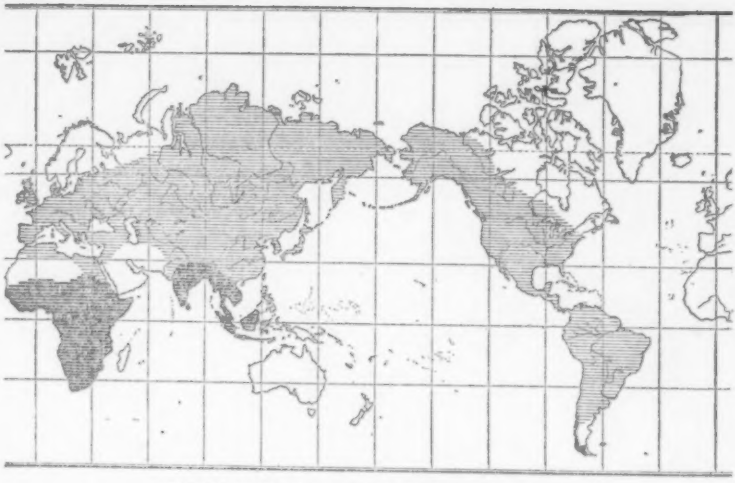

DISTRIBUTION OF ELEPHANTS AND MASTODONS.
Present
Former

FIG. 1

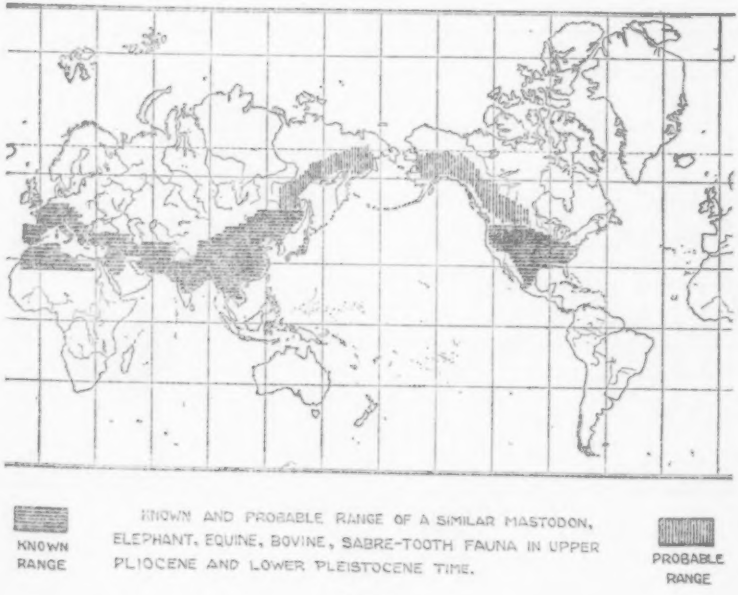
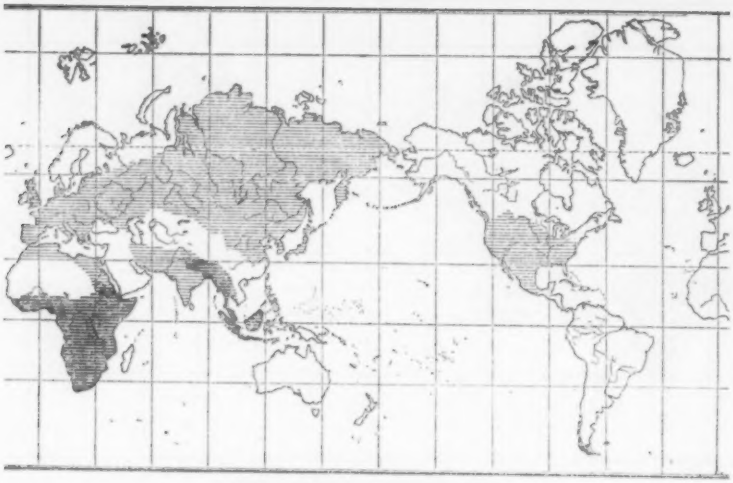

KNOWN RANGE
KNOWN AND PROBABLE RANGE OF A SIMILAR MASTODON, ELEPHANT, EQUINE, BOVINE, SABRE-TOOTH FAUNA IN UPPER PLIOCENE AND LOWER PLEISTOCENE TIME.
PROBABLE RANGE

FIG. 2

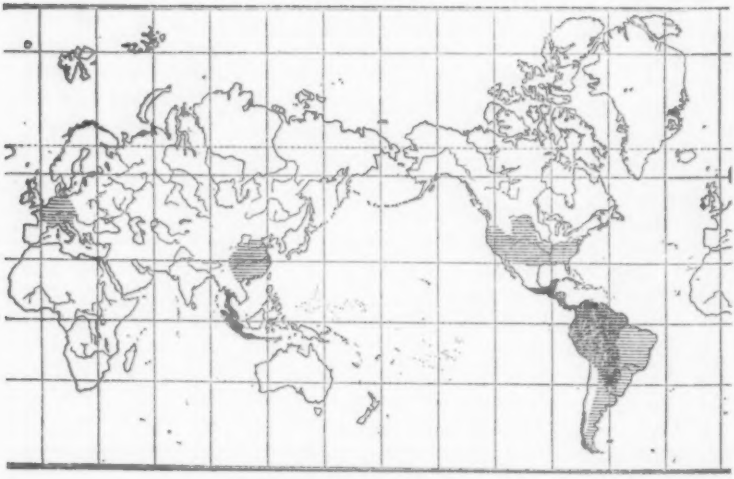


DISTRIBUTION OF RHINOCEROSES.

Present

Former

FIG. 3



DISTRIBUTION OF TAPIRS.

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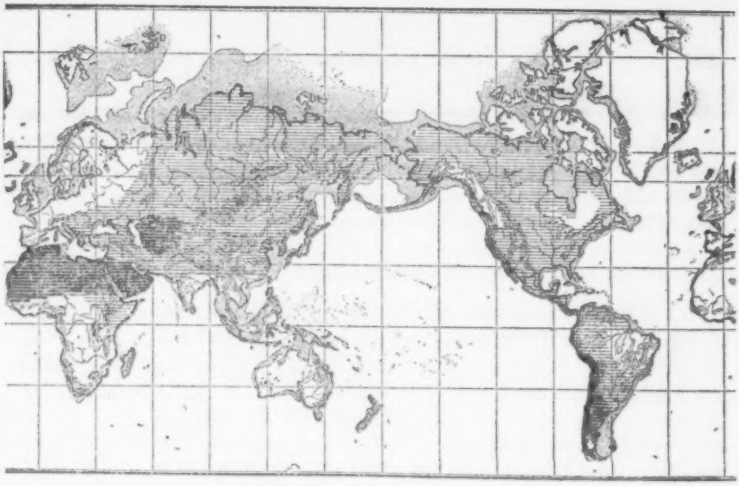
FIG. 4

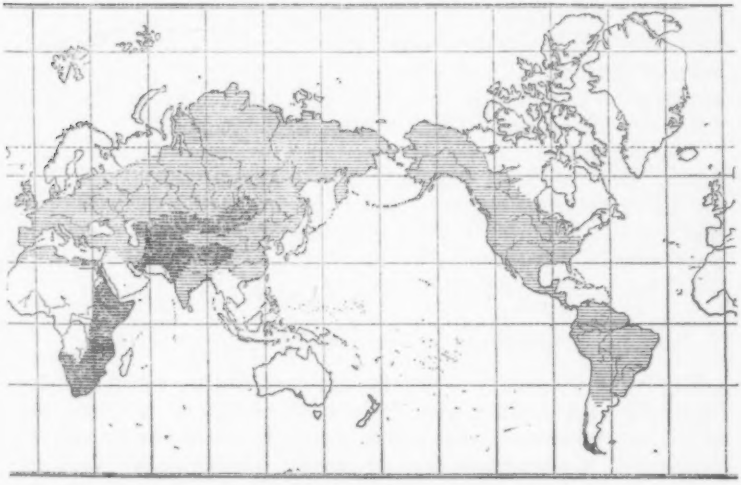


DISTRIBUTION OF CAMELS.

Present

Former

FIG. 5



DISTRIBUTION OF HORSES, ASSES AND ZEBRAS.

Present

Former

FIG. 6

tion of the mammals. Agriculture, the meat supply, and the fencing in of land is eliminating the game of Africa. Legitimate destruction by sportsmen had been comparatively a small feature. The meat market has been the chief cause of extinction of game animals throughout Alaska.

FORTY-FIVE YEARS OF PERSONAL OBSERVATION IN AMERICA

When Osborn first went to the Rocky Mountain region, as a young fossil hunter, in 1877, game animals were still universal. There was little agriculture and no barbed wire fences. Game was being killed off gradually by settlers and ranchmen, and, at times, ruthlessly by Indians. Bison were becoming scarce, but all the members of the deer family were extremely abundant and found wherever there was browse. With Sunday shooting he kept their fossil hunting camp supplied with meat—with mountain sheep, which were then in the Bad Lands, with antelope, and with black-tailed deer. Even as late as 1890, elk, deer, and antelope were extremely abundant in the uplands of Colorado. Elimination of game throughout this district is chiefly due to the winter supply of meat for ranchmen and, in a less degree, for the markets. All over the United States the legitimate meat for settlers and, to a limited degree, for the markets, has been the chief cause of elimination. Indians have come in and entirely cleaned out certain game retreats, like that of the Hell Creek region of Montana, which was full of game when Hornaday visited it in 1903.

Thus the three continents, Europe, North America, Asia, and finally Africa, have eliminated their wild animals through similar causes—the food supply, fur supply, industry and art, agriculture, deforestation, and, as a final blow but in a minor degree, sport. The number of game animals still surviving in the mountains of Asia is relatively great, but in many areas game is on the danger line.

RECENT DESTRUCTION OF FUR AND HIDE-BEARING ANIMALS

Nothing in the history of creation has paralleled the ravages of the fur and hide trade, which, with the bone fertilizer trade, now threatens the entire vertebrate kingdom. The legitimate use of furs for protection in cold weather has long since passed. Furs are now a fashion, just as feathers were thirty years ago. The trade has passed almost entirely into the hands of people of Oriental and Asiatic origin. Millions of dollars are spent annually in advertising. Furs are worn in

midsummer purely for ornament and personal adornment, or to make a display of wealth and luxury.

The final cause of the Close of the Age of Mammals can be arrested only through the creation of sound sentiment and education of the children and of women, in the same manner in which the National Association of Audubon Societies has arrested the destruction of birds. But such a movement will be extremely difficult, because the fur trade all over the world offers opportunities for money making, with very little effort and with no risk of life. Roy Chapman Andrews tells us that while he was in northern Mongolia word came through that marmot skins were coming into the market; the Mongols dropped all other work and began destroying marmots.

The best index to the destruction now going on among the mammals is afforded by a glance at the statistics of the fur trade. Anthony has compiled the figures for the years of 1919, 1920, and 1921, to show the large number of skins sold all over the country at the fur auctions, consulting a great number of fur-trade journals and reports. The best among these is the *Fur Trade Review*, a large monthly publication given over to everything of interest to the fur dealer. In the *Fur Trade Review* one can find a list of all offerings at the different fur auctions, and it may be assumed that these figures are sufficiently authentic to be used in this connection. In utilizing data of this nature, there are several features to be kept in mind. It is possible that the record of skins sold during any one year will not be a true record, inasmuch as, during a year of high prices, skins may be brought out of storage to be marketed under favorable opportunities, and in this way a large number sold during one year may have been collected over a period of several years. However, as we have had several "boom" years, it is quite likely that all of such stored skins have long since been brought out and disposed of, so that the more recent figures probably indicate animals killed within the year. Furthermore, lots of skins may be sold at the spring auction and shipped to another part of the country to be resold in the fall, consequently giving a duplication of numbers. In order to discount these figures and to keep them more conservative, we have omitted from the 1921 column the auction figures for the winter sale. This has, we believe, more than offset any duplication which may have occurred. The discounted total of all skins sold for the three years reaches the surprisingly large figure of 107,689,927 skins. Moreover, these figures indicate the slaughter of only the animals which reached the market as skins. To properly show the

slaughter that is taking place, one must allow for animals which were killed and not sent to the market because their skins were unprime, and also for a considerable percentage of wounded animals which escaped the trapper, but which, nevertheless, were killed through his agency.

	1919	1920	1921	TOTAL
Beaver, *Castor canadensis*	182,856	122,408	115,226	420,490
Muskrat, *Fiber zibethicus*	5,821,758	4,651,578	3,635,952	14,109,288
Nutria, *Myocastor coypu*	1,125,982	581,978	233,824	1,941,784
Squirrel, *Sciurus vulgaris*	6,304,777	5,109,181	3,444,358	14,858,316
White Hare, *Lepus sp?*	630,720	1,681,838	1,400,478	3,713,036
Mole, *Talpa sp?*	6,202,875	8,306,138	9,292,895	23,801,908
Mink, *Putorius vison*	704,148	575,265	404,487	1,683,900
Weasel or Ermine, *Putorius arcticus*	1,199,901	1,210,726	1,081,785	3,492,412
Kolinsky, *Mustela sibirica*	379,641	318,724	453,188	1,151,553
Skunk, *Mephitis sp?*	3,660,430	553,001	2,682,243	6,895,674
Alaska fur seal, *Callorhinus alascanus*	20,870	18,525	45,769	85,164
Wolf, *Canis sp?*	370,603	395,371	328,528	1,094,502
Red fox, *Vulpes fulvus*	348,875	531,433	414,950	1,295,258
Silver or Black Fox, *Vulpes fulvus*	11,709	7,547	7,094	26,350
Civit cat, *Syilogale sp? Viverra sp?*	906,553	601,177	606,805	2,114,535
Raccoon *Procyon sp?*	618,382	677,215	418,103	1,713,700
Sea Otter, *Latax lutris*	15	31	30	76
American Opossum, *Didelphys virginiana*	2,565,418	3,471,627	3,750,697	9,787,742
Australian Opossum, *Phalanger sp?*	1,133,917	2,061,349	1,070,355	4,265,621
Ring-tail Opossum, *Pseudochirus and Phalanger*	282,239	559,649	479,737	1,321,625
"Wombat" (Koala), *Phascolarctus cinereus*	2,998	121,435	84,244	208,677
Kangaroo, *Macropus sp?*	2,400	16,443	22,395	41,238
Wallaby, *Macropus sp?*	565,318	693,369	463,901	1,722,588
Total	33,042,385	32,266,008	30,437,044	95,745,437

A glance at some of the noteworthy species sought by the fur trade will show something of the scope and demands of this industry. Altogether, the fur trade utilizes, at the very least, some one hundred twenty-five species, the exact number being difficult to determine because of the employment of trade names, which mean nothing to the zoologist. We have included in the table with this paper only the more important species.

The figures showing the number of beaver (*Castor canadensis*)[2] taken demonstrate what proper protection of a fur-bearing species may do. Formerly trapped all over the continent, beaver were brought almost to the point of extermination, but for many years they have been protected and allowed to increase unmolested; now, over a period of three years past, some 420,000 skins have come to market. The muskrat (*Fiber zibethicus*) figures indicate how relentless has been the pursuit of this small rodent, an animal which at one time brought such a low price at the sales that it was scarcely worth while to trap it. When muskrat fur came into fashion and the public demanded it, systematic campaigns of trapping began, which brought muskrat skins to the market by the millions and seriously threatened the very existence of this species. Squirrel (*Sciurus*) skins, most of which we believe have come from the Old World, make up a huge total of over fourteen million in number, and this is another example of a skin, formerly very slightly valued, coming into prominence because of the demands of fashion. Still greater numbers are shown by the mole (*Talpa*). The skin of the mole is so small that only since the interest in furs has become extreme has there been any incentive for men to molest it. Most of the skins sold at these sales must come from the Old World, and the mole, as any one knows who has tried to trap it, is an exceedingly difficult animal to capture. Over twenty-three millions of these little animals were sacrificed at the altar of the fur trade. The mole, it may be claimed, is a small, insignificant species, and here and there along the list of fur bearers are animals for which little good or economic value may be urged, but the presentation of this subject is intended to show the great destruction of mammal life irrespective of species and the desirability of the extermination of any animal does not enter into the discussion.

The mink (*Lutreola vison*), which has been one of the favorite furs in the market for many years, is an animal which apparently is nowhere to be found in very great numbers. However, since its skin has brought such a good price at auctions, the country has been combed over for mink and the annual average yield of the last three years shown has been over five hundred thousand skins. This means a very serious

[2] The scientific names used throughout this article are those under which the animal is best known to the general public and to the fur trade. Recently accepted changes in nomenclature have been avoided because of confusion which might arise in the minds of those who have known these animals under the older names.

tax upon the ability of the animal to maintain itself. Ermine (*Putorius arcticus*) has been worn from time immemorial and has been the fur of royalty, and no less than 4,400,000 of these little animals have come to market over the three-year period. Before the recent craze in furs had begun, the skunk (*Mephitis*) enjoyed the immunity which nature intended him to have, and his skin brought such a low figure at the auctions that it scarcely paid to run the risk of removing it. Now skunk fur commands such a high price that the trappers refuse to be balked of their prey and over six million skunk were disposed of at the auctions from 1919 to 1921. When the killing of the Alaskan fur seal (*Callorhinus alascanus*) had reached such serious proportions that the government found it necessary to take a hand, and treaties had established the right of this country to protect the fur seal, the northern herds were placed upon a basis of protection and the annual killing controlled by law. This has been found to work out most satisfactorily, and a glance at the figures shows that over the three-year period more than eighty-five thousand skins were sold—a very satisfactory total when one considers the high prices per individual skin.

The average man may be led to suppose that wolves have become almost extinct over most of the country. In the figures given for the wolf (*Canis*), there are lumped together a great many species of coyotes and wolves, but, even so, the very large total of over one million skins is very significant of the great campaign that is being carried on against this animal, and at this rate it will not be very long before the wolf is extinct indeed. The red fox (*Vulpes fulvus*) has been such a prime favorite that great numbers of his skin have come to the fur sales, and we understand that in some regions of the north the fox is virtually on the brink of extermination. Over one million two hundred thousand skins taken during the three-year period point out a rate of destruction far greater than a species like the fox can survive. On the other hand, the rarer foxes, the silver and the black, have been protected and reared in captivity, and we have learned upon good authority that most of the skins sold at the sales are those of ranch reared animals. When upwards of twenty-six thousand ranch reared skins can be sold in three years, this furnishes a significant point for the consideration of the proper methods for supplying the fur market.

The raccoon (*Procyon*) is another animal which had but little fur value in early years; but to show how his status has changed, it will only be necessary to point out a total of 1,700,000 skins for the three-year period. The sea otter (*Latax lutris*), the most beautiful of all

furs, came to the fur counters to the extent of only seventy-six specimens, and this is a sad commentary on the disappearance of this animal. Inasmuch as the animal is protected over most of its known range, some of these specimens were doubtless taken illegally, and unless some radical change for the better takes place, it will not be long before the fur dealers must do without the sea otter.

One of the most widely sold furs is one which was formerly worth but a few cents and was seldom skinned by anyone but boys. We refer to the American or Virginia opossum (*Didelphys virginiana*), which, since it has come into fashion, has been skinned to the number of 9,700,000. The Australian marsupials have known to their cost this increased demand for opossum, and the drain upon the wild life of Australia is shown by the total of over four million for the so-called "Australian opossum,"—several species of small marsupials (*Phalanger*) going under this name—a total of more than one million three hundred thousand skins for the ring-tailed opossum (*Phalanger* and *Pseudochirus*), and more than two hundred and eight thousand skins for the koala (*Phascolarctus cinereus*), or, as it is known in the fur trade, the wombat. This latter animal has a skin almost worthless, when considered from the viewpoint of beauty and durability, but the fur traders have not passed up even so poor a fur bearer.

The Australians have been anxious to conserve their wild life and have shown this in their restriction of the number of native mammals which they have allowed scientific expeditions to take, but, on the other hand, their trappers have shipped out through the principal ports literally ton upon ton of baled skins, and whole regions have been stripped of the mammal life, so that Mr. W. H. Dudley Le Souef says some of the species have been brought down so close to the danger point that a year of drought will exterminate them completely over large areas.

The figures just cited give a little insight into what the fur trade is doing toward bringing about the Close of the Age of Mammals. In a few years some of the mammals now sought by the trappers will be killed off to a point where they will not repay trapping—the numbers taken being insufficient to repay for the expenditure of energy. Mammals are frequently subject to the attacks of different parasites, and are very susceptible to the spread of different epidemics. When the balance of nature has been disturbed and a species is brought to the point where the struggle for existence is precarious, it may happen that a species will disappear completely; in other words, be exterminated

by the appearance of some natural factor which it has been amply able to resist before its numbers were depleted by the demands of the furriers.

In Africa a number of animals have reached this point. Some of them have been killed off by natural causes, and others by the development of agriculture and by firearms in the hands of natives. In Africa epidemics appear to have unusually favorable facilities for spreading and many of the ungulates are standing upon the brink of disappearance. Mr. Herbert Lang has given us the names of the more important of the African mammals which have either disappeared or are about to disappear. We mention the quagga and the blauwbok, which have disappeared completely, while the mountain zebra, the bontebuck, the white rhinoceros, the okapi, the black wildebeest, the greater kudu, and the elephants of the Addo Bush are about to join them. The elephants of the Addo Bush are being systematically exterminated under government supervision, and the story of their downfall has been given in Hamlyn's *Menagerie Magazine*.

The center of the fur trade has passed over to this country. Before the war London was the world's fur market, but it now appears that the control has definitely passed over to the United States, and the great market of the present day is here with us. The figures given out by the Fur Dressers and the Fur Dyers Association show that in New York alone over eighty million skins were dressed and over ninety-seven million were dyed by the members of this association for the years 1918, 1919, and 1920. Thus it would appear that the heart of this industry beats in our own country, and if there is to be any prescription written, the initiative should be taken by us. The fur dealers themselves, for the most part, seem to realize that the wild animals are an asset of their industry, and judging by the editorials of the different journals, and the articles that appear, we believe that the majority of them, if the matter were put to a vote, would encourage a better method of trapping and a more extended control over the wild animal supply. It would suit their own purposes better if animals could be taken only during that part of the winter when they were prime; and the restriction of the hunting period to such a time of the year would be an important first step toward the conservation of fur bearers. But as matters now stand, when fur prices begin to mount to such figures that a few skins represent many dollars, then in the out of way places where laws have little significance at any time, men go out and kill every fur bearer that may come to hand, and run out their traps for whatever they may catch.

Therefore, we believe that if some more drastic methods of checking this perfectly appalling slaughter are not soon inaugurated, the fur industry will have been the means of quite definitely closing the Age of Mammals insofar as it applies to a number of species.

DISCUSSION BY PROMINENT MAMMALOGISTS

At the conclusion of the paper, Dr. W. T. Hornaday, director of the New York Zoological Park, who is the foremost advocate of wild life protection in the world, arose and commented on this joint paper. He began his remarks by stating that he thought Professor Osborn was entirely within bounds in saying that we were at the close of the Age of Mammals; that to his mind there was nothing more terrible to contemplate at this time than the grinding and devastating power of modern civilization as it is exerted, not only on animal life generally, but on vegetable life and on all the products of nature; that the human race is increasing and spreading, and it is also increasing in its power and ingenuity to destroy. The Zoological Society receives reports and communications from a great many far-distant portions of the world, where there is today the greatest abundance of animal life, and the story that is told by that correspondence everywhere is the same. It is the story of the continuous and alarming disappearance of the most important wild animal forms.

Taking Africa as an example, Doctor Hornaday said that a new influence has been brought to bear on the wild life of British East Africa, and of South Africa for that matter. The British government has been sending to British East Africa a great many ex-service men. They have been located there on farms, where they practically subsist on the resources of the country, living, to a great extent, on the game. Many of them are killing game wantonly, which they are well equipped to do, and none of them, he thinks, are preserving game. He stated that the Zoological Society had received most alarming reports from South Africa and from the Egyptian Soudan, and he continued as follows: "We are in close touch with men in the Union of South Africa, who are deeply interested in preserving the remnants of Africa's magnificent mammalian fauna and who will do all they can, under the tremendous handicaps that are upon them, to stem the tide of destruction. We have been called upon for practical assistance and the Permanent Wild Life Protection Fund is now on the point of sounding an alarm gong throughout South Africa, chiefly for the purpose of attempting to arouse the people of South Africa to the danger that besets their best, most interesting, and most vital wild life. Mr. Anthony has named to you a number of important species in South Africa that are threatened. It is no exaggeration to say that the kudu, the white rhinoceros, of course, and many others that could be named, are on the point of total destruction. Here in the United States we are engaged in a hand to hand struggle to save the pronghorn antelope from going down and out as a species, in spite of our efforts, and literally before our eyes. I think that there never has been an American species which has been so persistent in getting on the toboggan slide of its own accord as the pronghorn antelope. It is delicate in body. It is easily exterminated in the wild state, and now every tendency of civilization is to destroy it."

Doctor Hornaday then discussed the efforts of the American Bison Society to save the remnants. Taking the case of the state of Wyoming, he stated that the governor of Wyoming had said that the antelope is being destroyed by the homesteaders who have gone in there — in some instances having been induced to go in when they should not have gone — to locate on semi-arid lands; that in trying to live without irrigation and without any resources what ever of their own, and being hard pressed for food, they are killing the antelope and every other wild animal that they can reach; that there is no way of stopping it, there are so many of them that the state could not put in enough game wardens to prevent them from killing the animals. The governor is so thoroughly alarmed that he is now proposing a special state game preserve for the antelope. Doctor Hornaday believes that the handicaps on the antelope and the handicaps on those who will try to save it are so numerous and so great that the antelope is doomed to go down and out in about twenty-five years. The trouble is, when the antelope seems to be doing the best, something comes along and, in a twinkling, all is changed for the worse.

He stated that in far-distant countries, inhabited by savage tribes, it is now a lamentable fact that the natives are acquiring modern firearms. In India, forty years ago, the natives were not permitted by the Government to have firearms or to hunt with them. Now they have just as good breech-loading rifles as the English sportsmen, and they are using them very generally, and the English sportsmen say the game in India is being rapidly annihilated.

Doctor Hornaday continued as follows: "We must think in decades, quarter-centuries, half-centuries, and centuries. Geologic time is not for us. We are approaching the complete destruction of our wild life at express speed, and the rapidity with which the fauna and the best wild life of the world, that is, the mammal life of the world, is being destroyed, is ground for the most gloomy foreboding and confirmed pessimism. There are many far-sighted men and women who are doing their utmost to stem this tide of destruction and to save the depleted remnants for posterity. But what does it amount to? We may as well face these facts like men. We should not deceive ourselves. As a matter of fact, for every person who is putting forth active efforts to preserve the mammal life of the world, there are from one thousand to ten thousand, or even a hundred thousand destroyers. I have been devoting some thought recently to that subject. In the state of New York we have figures available. I have figured it out that in New York state, for every person who is actively engaged in preserving the mammal and bird life of the state, there are five hundred destroyers. In the West I think the number will be 1 to 1000; in Alaska I think it is about 1 to 2000; that is to say, for every person who is laboring to preserve the wild life, there are 2000 destroyers. In Africa, what shall we say? I should imagine that for every person on the continent of Africa who is attempting actively to preserve wild life there are 100,000 persons destroying it. We know that the great game preserves that are being created and protected at such great expense by the nation, by the states, by private individuals, and by a few other countries, will do something toward preserving some of these species from total extinction."

Doctor Hornaday stated that there are thoughtful men, of whom Mr. Madison Grant is one, who believe now, and have believed for some years, that a time will soon come when there will be no big game remaining in the United States or on the

continent of North America, save in the patrolled game preserves, and that he was fully convinced that this is true, and the only thing that is questionable about it is the number of years that will elapse before this is actually the state of affairs.

Doctor Hornaday believes we must not be discouraged in our efforts to preserve the remnants of the once glorious mammalian fauna. It is our duty to fight for it as long as we live. The close of the Age of Mammals may be ever so certain, but we have a right to hope that somehow and somewhere, in various places, fortune will favor our efforts. He said that the fur trade was doing its utmost to destroy everything that by any stretch of the imagination can be regarded as fur; that the destruction of the life of fur bearers has reached such a state that it is simply disgusting, and that there is no animal too mean or malodorous to be used by the fur trade.

Doctor Hornaday concluded by saying that he had far exceeded the time he had intended to speak, and that he closed as he began, by expressing his firm conviction that Professor Osborn and Mr. Anthony were absolutely right in saying that we are at the close of the Age of Mammals.

Dr. William Diller Matthew, chief of the Division of Geology and Palæontology of the American Museum, who has made a commanding study of the life of animals of the past and the natural causes of extinction, was then called upon to discuss the paper, and remarked, that, to his mind, the distributional maps that Professor Osborn had shown and the statistics that Mr. Anthony had placed before the meeting told the story of the disappearance of the great animals very impressively, and demonstrated one of the principal causes, at all events, for their disappearance. He said: "I do not think that one can fail to be fully convinced from these maps and figures. I think, however, that the maps and figures have underestimated the facts, if anything, as to the former great abundance and variety of animal life, and especially of the large animals. It is to be remembered that those comparisons are based only upon such types as have been found. There are many records of fossils in various parts of the world; but at the same time we are fa from having explored any part of the earth's surface thoroughly. There is no country in the world in which, during the last few years, explorers have failed to discover many new extinct types that have been wholly unknown; and skulls or skeletons of other types that have either been slightly known from small fragments, or have been regarded as animals having no real existence, merely products of the scientist's imagination or the itch for species making. In half a century from now we will look back at our present knowledge of the Pleistocene and Pliocene life of the world with the same amusement with which we read in the older textbooks the large words that cloaked the ignorance of fifty years ago. The plain fact is that we know very little, even yet, of the great varied mammalian fauna that inhabited the six continents at the end of the Age of Mammals.

Doctor Hornaday has shown the impending extinction—and extinction that seems almost unavoidable—of the pronghorn antelope. It is an animal that for various reasons we believe must be a solitary survivor of what was formerly a more abundant and varied group of animals. We have had no real evidence of that until comparatively recent years. We have at present three extinct relatives of the pronghorn antelope recorded. In the course of discovery of the next

half-century we may develop as large a variety of pronghorns and their relatives in this country as we have of true antelopes in the Old World.

I have given this instance of the pronghorn antelope simply to show that the Pleistocene and Pliocene mammal faunæ were really of great richness and variety, and it is, therefore, no exaggeration to state that there has been a very great reduction in the mammal fauna when we pass down to the mammals of today.

Dr. W. H. Osgood of the Field Museum of Natural History was then called upon and after agreeing with previous speakers, contributed a few further remarks to the discussion, giving his own impressions as to the contrast between conditions in settled regions and what one finds in going to those which have been practically uninfluenced by the forces of modern civilization. He stated that this had been his privilege upon one or two occasions in South America, where he had happened to penetrate into some of the few regions where Indians are still hostile and where conditions and surroundings might be said to be almost as they have been from the beginning. He had been particularly impressed in these regions with the very great abundance of animal life of all sorts, and especially of those kinds upon which man might be said to prey. Birds of large size, as ducks and gallinaceous birds, were found in such places to be as abundant as they were in this country when it was first settled, and he thought that this could also be truthfully stated about the members of the deer family and other groups of mammals. Such experiences bring an acute realization of the rapid changes that are taking place.

Dr. Charles C. Adams of the Roosevelt Wild Life Experiment Station, at Syracuse, added the following comments upon the Close of the Age of Mammals: He regretted the terrific destruction which was going on and stated that conditions surely demanded improvement. His solution of the difficulty would be to use the forces of education and the widespread use of preserves making these the main means to help stem the tide. This education should not be content to deal only with adults, because unless it began before maturity—with the younger generation—it would be useless. And neither did he think that such education could be limited to the Audubon Society, which is a specialized society for birds. There is an urgent need, he said, of an organization upon a conservation basis that will begin at the bottom and cover thoroughly the whole field. And this means also that the idea of preserves must be developed on a very large scale. Doctor Adams believed that the preserve idea is a most constructive feature, especially if some of the federal land be segregated and administered by the Central Government supplementing the National Parks and National Forests. The carrying out of this idea would mean an increase of our state parks and forests on a plan hardly dreamed of at the present time. Not only is there a call for large game preserves, but small game preserves and wild life or natural history sanctuaries must be established, since the purpose of education would not be served by a few large preserves which would be at a distance from the larger part of the population. The preserves must be so located that people may be taught the conservation of wild life near at home.

Another point that Doctor Adams brought out is the necessity for learning more of the life habits of the mammals; as a necessary condition for their intelli-

gent preservation and public appreciation. It would be only a partial remedy to establish preserves unless we know more about the habits of the mammals which we hope to protect in these preserves, and it is highly essential that more attention be paid to this intimate detailed knowledge of life history and ecology of our mammalian fauna. It is this aspect of natural history that has the greatest popular appeal and is most intimately related to economic problems.

He believed that men are coming to realize more and more the threatening features of the destruction of mammal life. There seems to be a feeling that opposition to this destruction is almost hopeless; that there is no use trying to stem the tide. While Doctor Adams granted that the problem is sufficiently discouraging, he regarded it in the same light as he did the question of our liberty, in the best sense of the term. Our liberty or our opportunities for living is a thing to be protected at any price, and the struggle for its protection must not be relinquished at any time. We cannot save wild life unless we go about it with the same earnestness and with the same refusal to acknowledge defeat that we would employ in the protection and conservation of our liberty. It is a similar unending process of adjustment to our conditions of life.

The discussion was brought to a close by the comments of Dr. E. W. Nelson, chief of the Biological Survey of the United States Department of Agriculture, charged with the Federal activities in relation to game and other mammal life. Doctor Nelson stated that the Biological Survey is engaged largely in the work of conservation and he has been more and more impressed, especially during the last few years, with the difficulties, and in some instances the apparently insurmountable difficulties, in the way of saving any considerable share of the existing large mammals of the world.

The rapid progress of modern civilization of man has accelerated the downhill procession of the other important mammals. Primitive man was simply one of the various predatory animals which preyed upon the coexistent animal life. At that stage man, like other mammals, was subject to the vicissitudes of his environment. Diseases or severe drouths or other inclement climatic conditions and other causes which destroyed wild life in general also destroyed a similar proportion of primitive man, thus retaining a balance in numbers which prevented the extermination of the animal life on which man preyed.

With the acceleration of modern civilization the powers of man to exterminate the wild life about him have increased marvelously, with the modern improvement of weapons and means of locomotion, which have been accompanied by the taking over of enormous areas of forests and plains for agricultural purposes. This has been accompanied by rapidly increasing populations and with an amazing increase in the number of hunters which go afield each year making a total annual bag of extraordinary proportions.

As a result of an inquiry of the state game wardens throughout the country it appears that in 1921 hunting licenses were issued to more than 4,000,000 hunters, while in many states landowners may hunt without a license. This with the number hunting in a few states which do not require licenses will undoubtedly increase the number of hunters who went afield in that year to exceed 6,000,000. The fact that any game survives after the hunting season in which such an army goes forth to shoot is amazing.

The main danger to wild life, however, has not been from hunting for sport or for individual use, but has been largely due to the commercial use of game, and its extermination to make way for the occupation of its territory by man. The commercial pursuit of game and other mammals for one purpose or another has made use of many improved methods of killing and transportation, until to-day the urgent need of limitations to such destruction of our wildlife asset is obvious. Attempts to conserve our wild game by the prohibition of its sale for commercial purposes, the establishment of bag limits and of closed seasons, and other legal methods, have been effective in delaying extermination. Public education as to the needs of a reasonable use of our wild life is also becoming more and more widespread.

As an instance of the demands of commerce for wildlife products may be cited the rise in value of muskrat skins until in 1920 they sold in Montreal at $7.50 each. The result of such prices was that muskrats were practically exterminated over great areas. Similar high prices for furs and an insistent commercial demand for them will menace the existence of all fur bearers not effectively protected by law.

In some areas, as in the State of Pennsylvania, an enormous amount of game is killed each year owing to the establishment of a considerable number of state game sanctuaries which serve as breeding grounds as well as refuges. Doctor Nelson believes that this is significant in indicating possibly a practical solution of the problem of wildlife conservation to the degree which the occupation of the states as a whole by man can permit.

For some years, he stated, the Biological Survey, with the United States Forest Service, has been working with the stock growers' associations of the West to bring about some agreed-upon policy for the conservation of game on the national forests, where vast numbers of domestic stocks are grazed. Many stockmen have taken the attitude that game is a nuisance since it takes some of the forage which stock might use. In addition, many stockmen have feared that game conservationists might desire to crowd domestic stock off the ranges in order to devote them to game. He believed that the movement among the stock growers was beginning to make headway, since at the last meeting of the National Stock Growers' Association, in Colorado, a resolution was passed recommending that study of game conditions on the national forests be made in order to work out a policy whereby game might be maintained along with the live stock. This is an extremely encouraging development.

Doctor Nelson agreed with Doctor Hornaday that the conservation element is a small minority and that they must keep everlastingly at the problem if they are to succeed. Discouraging reports of frightful slaughter are continually coming and these are not helpful to the morale of the conservation element. Indians have considered it their special privilege to kill wild game at will. He believes this source of destruction is a special danger which it is peculiarly difficult to avert in Alaska and northern Canada.

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NOTES ON TERTIARY SIRENIANS OF THE GENUS DESMOSTYLUS

By Harold Hannibal

[*Plates 11–12*]

During the past four or five years I have collected numerous teeth of extinct sirenians of the genus *Desmostylus* from the Miocene and transitional Oligocene-Miocene beds near San Jose, California.

The teeth of *Desmostylus* are of a unique type. When the tooth emerges from the gum it is made up of cone-shaped columns of enamel filled with dentine. As it wears it becomes a group of closely appressed enamel rings surrounding pits from which the dentine has been eroded.

A number of teeth together with bones and fragments of tusks were found in company with marine invertebrates in shell-limestone intercalated with the lower or buff sandstone member of the San Pablo formation on the San Jose Quadrangle between Monument Peak and the saddle where the road to Calaveras Valley crosses the first ridge of the Diablo Range. At a horizon only a few hundred feet higher a tooth was found in shell-limestone about a half a mile south of the saddle where the road to Mount Hamilton crosses the first ridge. A fragment of a *Desmostylus* tooth was also found in a mixture of limestone and rhyolite tuff interbedded with Monterey shale on the New Almaden Quadrangle northeast of the Guadalupe quicksilver mines. It was associated with *Pecten andersoni* Arnold and therefore comes from beds considerably older.

Desmostylus hesperus Marsh[1] on which the genus was founded was described from fragments of teeth and vertebræ collected by L. G. Yates in the Miocene of either Alameda or Contra Costa Counties, California. While the exact locality where the type was collected will probably never be known, the figure compares closely with a molar fragment found at the Monument Peak locality which lies only a few miles to the south. At several points in the San Pablo beds of Alameda and Contra Costa Counties I have seen fragments of vertebræ that I took to be sirenian remains and it is probable that Marsh's material came from this horizon.

The teeth from Monument Peak come from different parts of the mouths of many individuals. The most common teeth are first molar

[1] Marsh, O. C.; Am. Jour. Sci. Arts, CXXXV, pp. 94–96, fig. 1–3, 1888.

with seven columns and second and third molars with eight or nine columns, but the collection includes a milk molar with seven or more columns and two milk incisors, slender unicolumnar teeth. Fragments of two tusks having a length exceeding twelve inches and a diameter of an inch and an inch and a half, respectively, were obtained. They were found together and it is believed that they came from a lower jaw that may have held four tusks.

A second species of *Desmostylus* is found in Japan. In 1902, Yoshiwari and Iwasaki[2] described and figured a skull from the Miocene of Togari, province of Mino, which was subsequently named *Desmostylus watasei* Hay.[3] It differs from *Desmostylus hesperus* chiefly in the small anterior columns and heavier enamel of the molar teeth.

A third species occurs in the Oligocene of California and Oregon. In 1906 and 1911 Merriam[4] announced the find of teeth and tusk fragments of an unnamed *Desmostylus* in southern California, the San Joaquin Valley, and Yaquina Bay, Oregon. He figures (1911, p. 407, fig. 1a-1b) a molar tooth from the Monterey formation north of Coalinga (nw. $\frac{1}{4}$ sec. 29, T. 18 S., R. 15 E.) which belongs to the same section of the genus as *Desmostylus watasei*. Recently Hay[5] has figured as *Desmostylus hesperus* a skull and teeth from the mouth of Spencer Creek,[6] Yaquina Bay, Oregon. The molar teeth are characterized by heavy enamel, small dentine cores, and slender anterior columns as in *Desmostylus watasei* but the Yaquina skull is only about half the size of the Japanese skull with five columns instead of eight to the first upper molars and a corresponding reduction in other teeth.

Since the species is unnamed I propose to call it **Desmostylus cymatias** Hannibal, n.sp., from Cape Foulweather near where the Yaquina skull was obtained.

[2] Yoshiwara, S. and Iwasaki, J.; Jour. Coll. Sci. Imp. Univ. Tokyo, XVI (6), pp. 1–13, pls. I–III, four text figs., 1902.

[3] Hay, O. P.; Proc. U. S. Nat. Mus., XLIX, p. 396, 1916.

[4] Merriam, J. C.; Science, XXIV, pp. 151–152, 1906; Univ. Calif. Publ. Geol., VI, pp. 403–412, 11 text figs., 1911.

[5] Hay, O. P.; Proc. U. S. Nat. Mus., XLIX, no. 2113, pp. 381–397, pls. 56–58, 1916.

[6] I am unable to locate Spencer Creek no available maps but it cuts an area of Seattle shale and Monterey sandstone which are of Oligocene and Oligocene-Miocene age. Cf. Arnold, R. and Hannibal, H.; Proc. Am. Phil. Soc., LII, no. 212, pp. 582, 587, pl. XXXVIII, 1913.

The stratigraphic range of the three species is shown in the following table.

	CALIFORNIA	OREGON	JAPAN
Middle Miocene	*D. hesperus* in San Pablo formation of Monument Peak near San Jose		
Oligocene-Miocene	*D. cymatias* in Monterey formation north of Coalinga	*D. cymatias* in Monterey or Seattle formation at Yaquina Bay	*D. watasei* in Miocene of Togari, province of Mino

EXPLANATION OF PLATES

PLATE 11

Desmostylus cymatias Hannibal, n. sp.; Yaquina Bay, Oregon (after Hay, Proc. U. S. Nat. Mus., XLIX, pl. 58).

FIG. 1. Skull from left side. $\times\frac{2}{5}$. Explanation of numerals: 1, supraoccipital; 2, parietal; 3, frontal; 5, premaxillary; 6, maxillary; 7, lachrymal; 8, squamosal; 9, zygoma; 10, jugal; 11, capsule for second molar; 13, exoccipital condyle; 17, mastoid, 18, palatine; 27, tympanic cavity; 28, infraorbital foramen; 29, exoccipital.

FIG. 2. Skull from rear. $\times\frac{2}{5}$.

FIG. 3, 4. Supposed second molar. $\times 1$.

FIG. 5, 6. Supposed fourth premolar. $\times 1$.

PLATE 12

Desmostylus hesperus Marsh, $\times 1$; Monument Peak, San Jose, California.

FIG. 7. Fragment of a little-worn molar comparing closely to Marsh's type.

FIG. 8, 9. Worn second or third molar.

FIG. 10. Partly-worn second or third molar from another part of mouth.

FIG. 11. Partly-worn first molar.

FIG. 12. Fragment of an unworn milk molar which originally had seven or more columns.

FIG. 13, 14. Fragments of unworn unicolumnar teeth, probably milk incisors.

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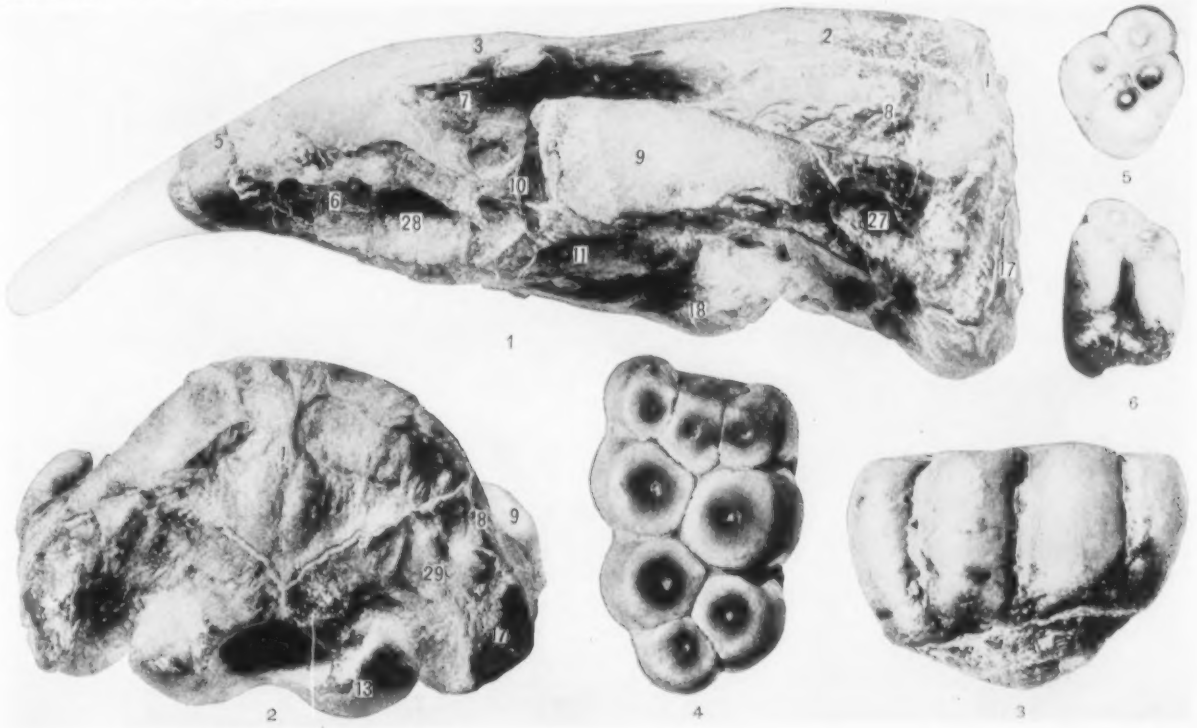
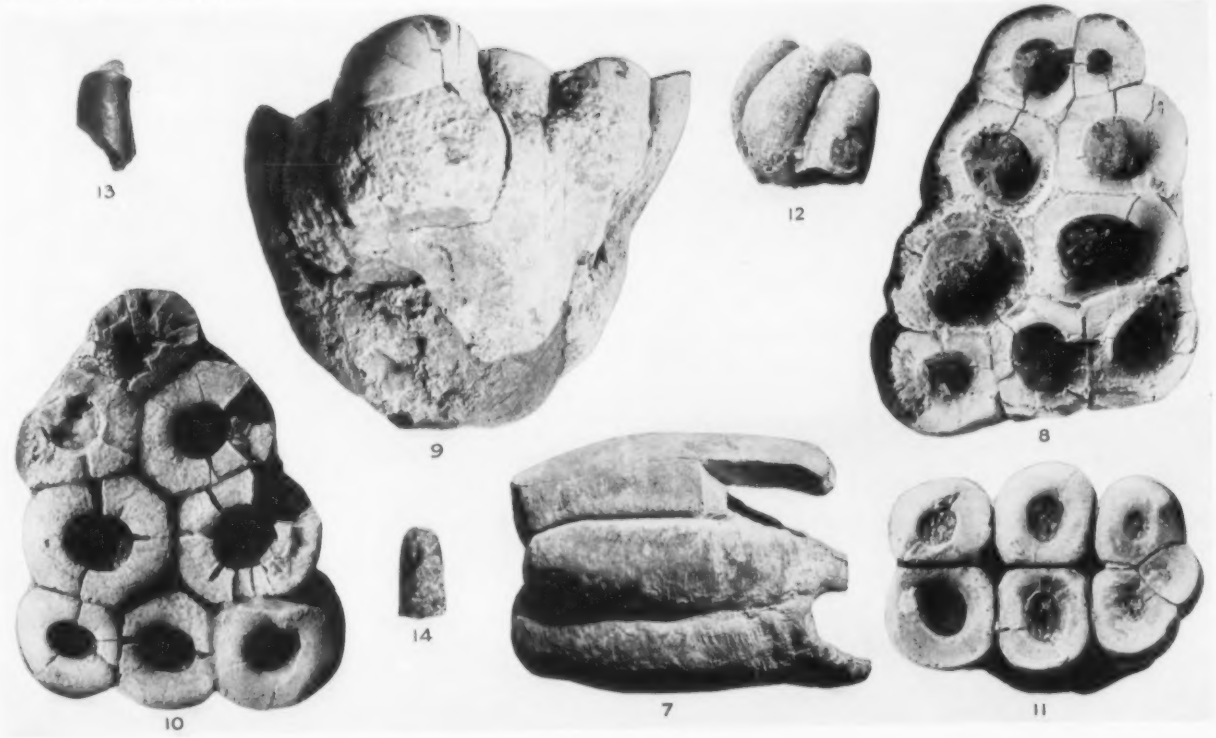


DESMOSTYLUS CYMATIAS HANNIBAL

(Hannibal: Tertiary Sirenians.)



DESMOSTYLUS HESPERUS MARSH

(Hannibal: Tertiary Sirenians.)

THE GENUS NEOTOMA IN THE SANTA CRUZ MOUNTAINS

By Harold E. Parks

Wherever he goes in the hills and woods of the Santa Cruz Mountains, California, sooner or later will the camper become acquainted with the little rodent commonly known as the woodrat. Not so much will he see of the animals themselves as of their astounding activities. To the camper, the woodsman, and the rancher the woodrat becomes a nuisance and a serious pest. Destructive to a high degree, versatile in its habits, adaptable to all conditions, it is an animal of considerable economic importance.

The prevailing idea is that there are two distinct species in this region but after lengthy observation I am inclined to recognize but one. This is *Neotoma fuscipes annectens*. Its varied activities have brought into common use the names "bushrat" and "traderat." The destructive activities are attributed to the bush or woodrat. The name traderat comes from the habit of replacing stolen articles with others, such as sticks, stones, dry bones, or pieces of dry cow manure. Variations in environment may account for these diverse habits but there is no apparent d'fference in the animals.

In the woods on all sides will be seen the nests of these rodents. Beyond recognition of the nests as the homes of the animals very little seems to be known of the inhabitants themselves. They are very shy and are seldom seen in daylight. On rare occasions one may be driven from a nest or seen wandering aimlessly in the trees during the day, but the activities are mainly nocturnal.

Several years ago in a camp in the mountains these animals became a source of annoyance. This camp was made in a steep little side canyon away from the travelled road and under some spreading live oaks. On the adjacent hills was a dense forest of mixed oaks, together with some madrone, redwood, laurel and the usual poison oak and hazel underbrush. The camp soon became the recipient of all kinds of attention, most of it very undesirable, from the rodents.

In the immediate vicinity of the camp there did not appear to be any of the nests of these animals. Within a few days however many articles of food began to disappear. Potatoes and pieces of bread vanished overnight. Very soon the entire supply of potatoes was gone. Then other things went. One evening a large piece of cold boiled meat was taken. Another night a large roll of jelly cake was taken.

I returned to my camp after an evening's absence just in time to see the roll of cake going under the rear flap of the tent. It had been rolled, pushed and dragged about considerably but showed few teeth marks. Several rats participated in this raid.

The so-called traderats carry away many very unweildy things, often to points high up in trees where nests have been made. They have a fondness for dried prunes, crackers, bits of glass, bright metal and sometimes pieces of brightly colored cloth and will carry such things to the nests for storage. In exchange they leave a chip, a small stone or anything that may happen to be handy and such things were frequently left in place of my bread and potatoes.

I have a record of a nest built at a considerable height in a pine tree that contained the bright inner lid of a lard pail stolen from the camp table, an old fashioned perfume bottle with a little mirror on one side, and many musty prunes and crackers. The perfume bottle contained gun oil and was rescued without the contents having been spilled. I have seen many other dexterous performances by these animals.

I watched many days with a little rifle handy to destroy my visitors before seeing one of them. In the meantime I went in search of the nests and found a colony established in a dense thicket of hazel brush in an almost impenetrable side gulch three hundred yards from camp. In this thicket were a dozen large conical nests of the type most commonly seen. These were built in such a way as to receive considerable support from the large stalks of the hazel which was very rank in growth. These piles of dry sticks were like so much tinder so I fired them, the surrounding vegetation being wet and green enough to prevent fire from spreading. Fire was applied at the top and burned rapidly downward. As they were fired one at a time I watched for the fleeing rats but saw none. The occupants took to underground passages and later came forth and proceeded to rebuild. In a few days the nests were well under way and assuming good size. Had a general fire run through the brush they would have deserted the locality for an unburned site. I have recently (1919–20) witnessed extensive burnings of brushy areas to rid a neighborhood of rats and within a month many new nests were in process of construction a very short distance from the burned area.

One morning while at an early breakfast under the trees at my camp I noted considerable commotion in the branches overhead. A half dozen small animals were running back and forth at play, unconscious of or unconcerned at my presence. I did not attempt to destroy them at this time and in several days they became quite tame showing

no fear of any one around the camp. They appeared regularly morning and evening and quite frequently came down to the ground for bits of food.

To me they appeared quite stupid and rather sluggish in movement. They did not move with any great speed and such of them as I have seen at distances from the nests did not take alarm very easily. It may be that their great curosity overcomes fear to a certain degree.

Eventually these little visitors became such a nuisance that the rifle was brought into use. Sitting at my table I shot six of them as they sat in the branches of the tree above me. They made no effort to get away, simply squealing a little at the noise but otherwise appearing unafraid. They presented a ludicrous and helpless appearance.

They were all apparently dwellers in a nest located in a large oak at some little distance from the camp. I could trace their course of travel through the trees from that vicinity. I have since seen regular courses travelled by rats through the madrone thickets, regular paths being worn in the tender young green bark early in the fall. These six rats were of an even size and were always seen together and I have thought they were all of one litter. They were four to five inches long with a tail a trifle longer than the body. The fur was of fine texture and condition although it was the middle of May. It was clean, soft gray on the sides and back and pure clean white on the belly. The head was short and rather heavy in appearance with a blunt nose and short, rounded, erect ears. They had the look of rats approaching maturity.

I have since found stray animals about a third larger than those mentioned. These latter were probably old as they had dirty gray fur and a more rat-like appearance. On the ground they were slow of movement but were much speedier in the trees. Aloft in the trees they were not inclined to run far or escape when observed. They would stretch their bodies lengthwise along a limb without much attempt at concealment and then follow every movement of a person on the ground with their eyes. Unlike the squirrels they do not seek to keep the tree between themselves and an observer. When shot at with a rifle they would sit up on their haunches and squeal but make no attempt to run away.

On occasion I have disturbed rats and forced them into the trees where I have thrown sticks at them with the intention of making them move rather than to injure them. If the missile passed close enough the rat would move a short distance and wait for another missile to be thrown. The result almost invariably was that the rat would travel

in a circle that kept it in close touch with the nest. If the nest was destroyed the rat could then be driven away immediately, usually to a small refuge nest high up in the trees.

NESTS

The dwelling of this woodrat and the methods used in its building are of much interest, even though these nests appear to the casual observer to be nothing more than piles of dry sticks and trash. The animals are versatile in their adaptability to their surroundings, in the methods of construction, and in the utilization of materials; and are exceedingly dextrous in the handling of large and unweildy objects.

Before going into details of the structure it is necessary to know something of the requirements of the animals. They appear to be sociable by nature. In one case I found evidence of two families occupying one large nest. Frequently hard and well worn paths will be found leading from one nest to another, indicating intercourse between them. Usually the nests are to be found in colonies, isolated nests being exceptions.

In certain localities where I have collected botanical specimens the nests are built in every thicket, against trees and around stumps, and in the branches of the trees, in fact in every conceivable place that affords the needed support and protection. The methods of utilizing these facilities are often unique and ingenious. The preferred places are in the dense forest but sometimes the nests are built on open rocky ledges. In the latter case they are solitary and small.

Conditions to be met in the selection of sites for individual nests and for colonies are the sources and abundance of food supply, the general safety and security of the nests, and the ease in securing the needed building materials. Proximity to water is not essential and the animals often travel considerable distances to it. The presence of humans is not taken into consideration, although they delight in raiding habitations and belongings.

I have on occasion come upon rats beginning the construction of a nest. One pair began at the base of an oak and made an excavation on the downhill side that ran back at an angle a foot in the hard, finely pulverized, rocky soil and was so placed as to receive the greatest amount of protection from the base of the tree. They next gathered a large number of small twigs, most of them freshly cut, which they piled in such a way around the opening as to form a chamber above it. This fine material they then covered with larger and coarser material

until they had a considerable pile of sticks. Into this upper mass they wove many long, green boughs of freshly cut laurel and vines of different kinds with some long sword ferns and filled the interstices with dry cow manure brought from an adjacent pasture. In the course of several weeks this nest became a structure of considerable size and strength.

Apparently this mass was piled more or less aimlessly around the base of the tree but the effect was to bind the nest securely together. The entrance, as in many others, was at the base on the lower or downhill side. The amount of debris that accumulated around the base of this nest seemed to indicate considerable extension of the original cavity and the running of some small lateral tunnels.

The material used in these buildings is subject to rapid decay. Most of the woods used are soft and light and yield readily to the gnawing of the rodents. When manure, vines, and ferns are used the process of decay is accelerated. This decay necessitates a constant renewal. At the edge of a forest I have found nests that were built around fallen oak logs and stumps and the material used in the construction was such that little renewal was required. In the fall months all nests are gone over to some extent. This work begins at the approach of wet weather and frequently continues until the long dry season sets in. During the summer season there is a general appearance of dilapidation.

A nest on the edge of the forest will show some signs of freshening up and a considerable amount of debris will be removed from the interior, while nests in the dense forest will frequently be buried under masses of manzanita and toyon. Neither wet nor cold seems to influence the amount of this rebuilding. In the spring there is a season of cleaning house and large amounts of filth, dirt, droppings, and decomposed material is dumped in heaps around the entrances. The nests are again covered with long laurel withes or branches clipped from redwood or manzanita and vines like the wild cucumber and with ferns.

A large house is not necessarily an indication of a large community occupying the nest. Size is attained by the constant addition of material required for the protection of the nest and its occupants. There is very little evidence in many of the nests which have been dismantled, to show that the upper portions of the structure are used for any purpose at all and only in a very few have any open chambers been found above the main quarters. Where these chambers have been found there is nothing to indicate the purpose for which they were made. The breeding nests are in the lower chambers close to the under-

ground passages and there is an absence of filth around them. The living quarters are generally filthy.

The larger a nest becomes the greater is the amount of work required to maintain it. Its length of life extends over a number of years of slow growth followed by a comparatively rapid decay when the forces of nature have become too great to overcome. In wet weather the nests absorb a large amount of moisture which is held for a long period and adds very materially to the rapidity of the decay. Then there comes the long, dry, desiccating summer weather when the soft materials crumble to dust.

The rats are not satisfied with the underground retreats for they build small refuge nests high up in the trees in the vicinity of the ground nest. When driven from the safety of the latter they will take to the trees and finally seek the shelter of the tree nests. A sudden sharp blow upon the ground nest will frequently scare a rat into the trees and on rare occasions one will go directly to the tree nest. More often the rat will remain in the vicinity of the main nest until compelled by force to leave it. If a person begins to dismantle a nest at the top the rats will seek the underground passages and none will be seen on the surface. I have succeeded in driving out one rat but have not been able to get sight of a second in any nest.

I once dismantled a nest that had reached its maximum development in an exceptionally favorable location. One side of a huge redwood stump had been burned in a fire and then broken off leaving a stub on one side while the fire continued to eat its way down the other into the roots. The side exposed to the heavy weather remained standing and the inner portion of it formed the bracing side for the nest. Against this upstanding slab there was piled an enormous amount of trash.

Beginning carefully at the top I removed a considerable pile of coarse sticks and rubbish, finding only a few small open chambers. When I had reduced the pile by fully three-quarters of its original bulk I came to a large chamber. This chamber was larger than usual but had not been cleaned out at the end of the rainy season and was very filthy. In one corner there was a small nest such as some bird might build. This nest was carefully woven of fine long grass and wood chewed into a resemblance to excelsior. The center was perfectly hollowed out and lined with soft fur. It was some five inches in diameter and four inches deep. This nest had been recently occupied and the young I think had been removed to some underground passage.

There was an entrance to an underground passage on the opposite side of the chamber to this breeding nest. This underground passage was an old burnt out root about ten inches in diameter and four or five feet below the level of the ground and extended laterally to a river bank some few feet distant. I ascertained this by starting a smudge. I forced some smoke into the hole and drove a rat out into the open on the bank. This nest was not rebuilt.

Unusual forms of construction are frequently met with and are often a puzzle. I found several along the rocky ledges at the Guadaloupe Mines which were but little more than heaps of sticks piled around deep holes or crevices in the rocks, the material in which must have been secured with difficulty. I endeavored to interview the occupants of one such nest with some unexpected success. One of the occupants was a very long slender snake, probably a California striped racer, which proceeded to race back and forth through some brush but I could not make it leave the vicinity of the nest. It is said that rattlers sometimes use these nests but although I have had some painful experiences in trying to prove it I have never found the rattler in the nest. If the rattler occupies the nest he also eats the rats.

I have observed many strange nests this last season or two, but none of them illustrates the ingenuity and dexterity of these animals more than one which was found on the site of an abandoned farm near Los Gatos. The nest was built in the crotch of an ancient laurel which had partly decayed as these trees frequently do. The usual brush and rubbish was piled loosely around on the ground. Above this was an immense pile of shingles built into the crotch of the tree to a height of five feet or more, all laid flat one upon another and securely braced to prevent falling. These rats had carried shingles a hundred feet or more from an old fallen roof and piled them with an infinite amount of labor.

In the Guadaloupe Mine region where there are some very large coast live oaks (*Quercus agrifolia*) the rats have taken advantage of heavy crossing branches in a unique way. Two nests were located close together in adjacent trees where the outer limbs crossed and braced each other and formed a solid base to build upon. The builders used three crossing limbs as the foundation and then drew in the smaller branches as the nests grew until the whole nest had attained a height of five feet or more and the base an area of nine or ten square feet. Although these nests swayed back and forth with the heavy winds they were very solid and difficult to take apart. These nests were two

seasons in the building. Each contained a large central chamber. In each nest I found a single old rat and signs that young had been in the nests recently. One of the curious features of these nests was the amount of dry manure used in the construction. Fully one-third of their bulk was made up of this material brought from an adjacent pasture.

FOOD AND FEEDING HABITS

There is plenty of evidence that the woodrat is a gross and destructive feeder. The animals are wanton in their ravages, destroying great quantities of things for which they have no use. It seems to be their special delight to enter cabins and ranch houses or other buildings and chew up papers, books, clothing, and whatever else they may find and such debris is left in heaps wherever it has been destroyed.

I have never seen papers or kindred articles in the nests or signs that they have been taken any great distance from dwellings. Bits of bright cloth like other bright things may be carried to some distance. At the cabin of a friend the food supplies were regularly raided and the salt and soap seemed to be favorite articles. One spring my friend missed some silk socks and a bright necktie. In the fall we found both in remnants together with some soap in a nest a quarter of a mile away. The rats seemed to develop a streak of mischief with a bit of humor and persistence in it. Every night the woodbox in the cook shack was a center of attention. This building being more or less open the rats had easy access at night. In the morning the wood was to be found on the floor, the pieces being laid out in rows and placed neatly end to end. This was repeated many times.

The season of 1919 produced an abundance of wild berries and fruits. The madrone trees bore enormous crops of the bright red berries which are known as the favorite food of the robins and wild pigeons of this region. In the vicinity of my friend's cabin the madrones are very abundant and the woodrats are also present in very large numbers. When we were opening some of the nests in search of young we found great numbers of madrone berries, which had been cut from the trees in clusters and taken to the nests as needed. This fruit must have been used to feed the young since the old rats eat what they require where it grows. It is a significant fact that the berries were placed conveniently near the little breeding nests that had contained young very recently. The berries are not eaten for the pulp that surrounds the large seeds but in the nests they are cracked open and the kernel is eaten as we would eat a nut.

No permanent food supply seems to be laid up regularly for winter use as is the case with the northern rodents. The climate is such that there is a constant supply of food of some kind available the year round. The conclusion is that when food is found in the nest it is there for the feeding of the young. During many months of the year when there are acorns to be found the rats are industrious in gathering them for food, but they are in the greater number of cases consumed where found. On two occasions in the fall of 1919 when examining nests I found acorns of live oaks stored for use directly in front of the breeding nests. The little nests had contained young within a short time of my visit and fragments of freshly eaten acorns seemed to indicate that the young had eaten of them within an hour of my opening the nests. In these piles I counted over five hundred acorns without taking more than half of them.

In one nest after removing the acorns I found a peculiar arrangement of the underground passage in which the young probably took refuge. The central chamber was quite large, the breeding nest was at one side with a passage beside it, and the acorns were piled on the opposite side with a mat made of the fine, long, tough twigs of a species of wild cherry beneath them. The main passage way passed directly beneath this mat and furnished the rats access to the pile of acorns without coming to the main chamber.

Fungi form one of the most important foods of the rodents here, if not the most important. One variety or another is to be found through a very long season if the rains are sufficient. It is in those winters when the rainfall is light that the rats make the greatest use of acorns and other foods. The botanical field work that I am doing relates to the groups of fungi which grow under the surface of the ground or are buried under the leaves of the forest, and are practically unknown in this country to any but a few scientists.

The collector of this kind of fungi in America is handicapped to a very great extent as he must choose his working place at random or by instinct. In Europe where truffles as well as others of this class are abundant, the fungi are strongly aromatic and certain animals are trained to search for the hidden plants. Unfortunately, while truffles in California are abundant, they are not in any sense aromatic. The plants give no evidence of their presence and must be located by some other means than by smell. We have another group of plants which may be called false truffles (i.e. *Hymenogastrales*), since they grow after the manner of the real truffles and some of the many species

are exceedingly aromatic. It is this latter group which is closely associated with the woodrats. To the woodrats or to the signs they leave, credit is due for many important discoveries. These signs and the reading of them are most important to the collector who desires to secure specimens of this kind.

There is a district within easy reach of San Jose which I visit frequently in following up the life cycle of the various species of fungi. This is the region of the New Almaden Mines and the Guadaloupe Mines. The rats are or have been assembled there literally by the thousands. It is a region well favored with all kinds of fungi. It is wooded densely with a second growth of liveoak interspersed with the usual underbrush of manzanita, *Baccharis* and poison oak. The soil is largely pulverized rock and quartz. For a long time I got very poor results in the collecting of fungi but occasionally I found large specimens of the Agaricaceæ and Boletaceæ which had been partly consumed by some small animals. At the same time my attention was frequently called to many excavations in the leaves and hard soil. These excavations were very puzzling but I had in mind the fact that some animals fed on truffles in Europe and that there might be a similar occurrence here.

The mystery of these holes in the ground induced me to return many times to this region long after it seemed that search for the truffles was useless. Persistence in following up these signs led to the finding and developing a district wonderfully rich in these strange forms of fungi. Months were spent in learning the meaning of these signs and excavations made by rodents but now they are read with as much certainty as a printed page. The form of the excavation often serves to identify the various genera of fungi present. But it is important to note that these signs do not reveal all that is undergound. The woodrat is the mushroom hunter par excellence.

Late in March of 1917 I was in the Guadaloupe Mine region following up some discoveries of a few days before. I became involved in a dense thicket of manzanita where progress was made only on hands and knees. I shortly brought up before a rat's nest of large size and disturbed a rat working in a hole at the base. Examination revealed several other holes in process of excavation and one large hole about four inches in diameter at the top and nearly a foot deep. At the bottom of this hole was a large fungus, strongly but not unpleasantly aromatic, which was partly eaten.

I completed excavation of the other holes and secured seven fine specimens of this fungus, all strongly aromatic. I assumed that these plants were desirable for food for the rats and associated the many excavations which I had been finding with the work of the woodrats. I also assumed that there must be some relationship between the location of nests and the location of desirable fungi. The conclusion arrived at after considerable study, was that where the woodrats were numerous the fungi must likewise be abundant. This is well borne out by subsequent discoveries. This particular fungus, genus *Gautieria*, I have never found at any great distance from rat nests. The plants of this genus are, in this locality, rarely found less than six inches and frequently nearly a foot below the surface. They are seldom found in any but very dry ground which is firmly packed. This condition requires a great amount of digging. When a mature fungus is located by a woodrat a hole is excavated until the plant is visible. It is then eaten in the hole. I have found many of them partly eaten in the holes but have never seen one removed from the hole. It is some feat for the rat to stand upon its head and consume such an article of food.

The genus *Gautieria* is found in abundance in normal moist seasons in this region from November to July. It is perhaps the most powerfully aromatic of all the species without being so foul as some are; beyond doubt it is one of the most esteemed of all the fungi and forms one of the most important foods for the woodrat.

In one place the rats opened up a series of holes around the sides of a steep, wooded ridge very much as a miner would sink test shafts in developing a vein of ore. In this way they followed for considerable distances parallel veins of mycelium, opening up holes at intervals of two or three feet and consuming the matured fungus at the bottom of each. By opening up the exposed veins between these holes a large number of plants were collected in their immature stages and which had not yet developed an odor. The woodrats seem to ignore the plants that have not yet developed to this state of maturity. It is solely by the sense of smell that the plants are found. I have seen other plants cast aside in the excavations because they lacked an odor.

There are several other species scattered through these hills in more or less abundance which have not been described scientifically and which form a very considerable item in the food supply of the rodents. These are all strong-odored varieties. They are all more or less buried in the soil and humus and are to be found by digging in appropriate places. Some are found among the leaves, others beneath the leaves

but on the surface of the soil, and still others at various depths beneath the surface. Occasionally they are found uncovered on the surface of bare soil but always beneath various trees.

One of these plants of somewhat common occurrence (genus *Melanogaster*) possesses an exceedingly powerful, spreading odor and is to be found growing among the leaves. It has the appearance of a small puffball of a reddish or brownish color. The rats range far and wide for these plants during the season and when they find them they turn over the leaves and humus sifting it into a fine mulch in their efforts to secure the fungus. These, as in the previous cases, are eaten on the spot. Being of the consistency of a rubber ball they make a rather tough bite. In spite of the very strong odor, the plants are, to the human taste, rather sweet and pleasant.

Some of the species serving the purpose of food for the rats are very malodorous, others somewhat pleasant. There are two species widely divergent in size, appearance and genera (*Hymenogaster* and *Hydnangium*) which have the same relative odor resembling that of witch hazel. Both are much sought after in season.

One of the remarkable facts established is that in each genus there is one species which stands out from the others in this matter of odor. It might be said that there is one species which represents the type of the genus because of its marked characteristic odor. This one species seems to be the most abundant one of the genus. The other species seem to have this character modified until the odor becomes almost negligible. Correspondingly their use by the rats decreases.

There is one fungus (genus *Hysterangium*) which seems to stand above all others in some respects in its relation to the rats and I might add, to the person collecting it. It is in appearance like a little white puffball with a tough rubbery gleba usually of a green color. Its predominant character is its exceedingly vile odor when mature. It is almost impossible to carry the plants in a collection, so offensive is this odor. Its habitat is among the leaves or slightly buried in the ground where it is easily accessible to the rodents. Where it is to be found the rats will pass by all other fungi to get it. I have seen the fragments of the white peridium scattered over considerable areas of the forest and excavations are to be found everywhere. The peridium seems to be rejected for the tough gristly interior portion. It is frequently to be noticed that many young plants are left, the rats taking only those which have fully matured.

At Guadaloupe Mines I found an exceptional location where the humus beneath the oaks had accumulated to a depth of a foot or more.

In this bed of leaves were signs of rat excavations showing the trend of a vein of mycelium of this offensive fungus. I uncovered a considerable area and secured some specimens. Along this vein I opened up another vein of mycelium belonging to another species of the same genus. This latter species is very different from the offensive one, particularly in the matter of odor. This odorless species was rejected. To the human taste there is no perceptible difference. This latter plant is larger and more attractive but not so common. Enlarging the excavation to the base of a very large rat nest I encountered still another genus (*Octaviania*) with a number of fine large plants. These were all mature but not odorous and some of them lay alongside of the offensive species. Many of them had been uncovered by the rats but all were ignored.

In many of these excavations I have found many different species of the real truffles but only once have I found one that appeared to have been eaten by a rodent and this I think had been bitten by a gopher. The truffles are all very finely flavored but apparently few of them have any perceptible odor which I think is the cause of their rejection for food. I have found in several places however a species in a genus very closely related to the truffles which has a very strong odor and was much sought for by the rats. This one (genus *Elaphomyces*) is abundant in the center of a large rat colony in the vicinity of Saratoga. In excavating for this species the rats opened up a trench exposing the mycelium for several feet at a time. This mycelium is found at a depth of four to six inches and the fungus is imbedded all through it.

In time of scarcity in the winter when a cold snap has destroyed most of the fungi the rats are frequently put to it very hard to secure the necessary food supplies. At such times they resort to the remnants of common fungi remaining above ground. Wanting these they go to extremes to satisfy their appetites. I have found half gnawed buckeyes, large galls from certain oaks, and other things within the nests. Twice this last season (1921) have I seen the thick bark of live oaks girdled by rats. They are persistent in their search for newly sprouted acorns.

All of the fungi mentioned are to be found in the collections filed in the Herbarium of the Department of Botany of the University of California at Berkeley. Acknowledgments are due to Dr. W. A. Setchell of the Department of Botany and to Mr. Tracy I. Storer of the Museum of Vertebrate Zoölogy who have been more than helpful in the preparation of this paper and in many other ways.

Berkeley, California.

DR. JOEL ASAPH ALLEN—AN APPRECIATION[1]

By E. W. Nelson

[*Plates 13–14*]

With the passing of Dr. Joel Asaph Allen modern American science lost one of its foremost pioneer leaders. It was my privilege to know him for a period of more than 45 years. First when as a boy interested in birds in northern Illinois I secured there the first specimens of a sharp-tailed sparrow. Doctor Allen learned of this and at his request they were forwarded for his examination, with the result that he described the bird as a geographic form previously unknown to science. This was followed by his kindly encouragement and a personal interest in securing the publication of several of my first papers on birds, thus supplying some of the final factors which resulted in my decision to follow a scientific career. I believe that many other beginners were similarly helped through his direct intervention.

From the time of our early communications I regarded him as a personal friend, and in later years when we came into more direct contact we passed many enjoyable hours together, both in his office and while I was a guest in his home. In social intercourse his quiet geniality made him a delightful companion. The persistence of his work did not rob him of the power of seeing the humorous side of things nor of a quiet but lively appreciation of fun.

Another little-known phase of his experiences and character was uncovered when after knowing him for many years I accidentally learned that in the early days he had personally made large collections of big game in the West for the museum at Cambridge and that he had been more than an average good shot with a rifle; those collections including bison, elk, deer, antelope, and mountain sheep, with numerous smaller species. During one of my visits at his home I brought up the matter of these experiences and was deeply interested as he described many of the episodes in securing these specimens. His sparkling eyes and unusual animation showed that under his quiet demeanor he must have possessed much youthful enthusiasm.

Comparatively few men living now can appreciate the difficulties that beset the path of the young naturalist in the days when Doctor

[1] Presented at the dedication of the North American Mammal Hall in the American Museum of Natural History, to the memory of Doctor Allen, during the fourth annual meeting of the Society in New York, May 18, 1922.

Allen began his work. The contrast between the conditions confronting the embryo naturalist then with the easy road of scientific research today may be likened in a material way with that between an old stage coach traversing a rough country road and the modern automobile on its cement highway.

In the early days of his career, from 1850 to the early seventies, fellow naturalists as well as scientific publications, scientific libraries, and collections, were exceedingly rare, and the young student in any branch of natural science was looked upon as following a pursuit of no importance or value to the community. Under such handicaps persistence in making natural science a life work meant the devotion of an enthusiast. We might paraphrase an old saying by stating that "A naturalist is born, not made," with full force in its application to a man like Doctor Allen, who at the age of 13 was irresistibly drawn to the path which he followed to the end of his life.

He was fortunate in having been born in eastern Massachusetts, where he eventually became one of that small group of men who studied under Agassiz and who afterwards became notable leaders in their various branches of science. He was also fortunate in having an opportunity as a young man to do field work under such varied conditions as those presented in New England, Brazil, Florida, the Mississippi Valley, and some of the Rocky Mountain States. This field experience was invaluable to him subsequently during his many continuous years of laboratory work. It broadened his knowledge of birds and mammals in life and their relationships to their environment, giving him a fund of invaluable facts which were most useful in his philosophical consideration of problems of evolution and of distribution.

Doctor Allen had a philosophical mind which looked into the meaning of the facts of Nature, and his ideas concerning evolution and the distribution of life in faunal areas were set forth in numerous papers. One of the earliest and most notable of these was his "Mammals and Winter Birds of East Florida." His writings exerted a marked influence among American naturalists in directing their attention to fascinating fields of investigation of broader scope than that of identifying species and recording technical characters.

He was one of the leaders in organizing the Nuttall Ornithological Club, at Cambridge, and later was one of the three men who issued the call to organize the American Ornithologists' Union, which was the child of the Nuttall Club. Through the enthusiasm aroused by this organization American ornithology developed with extraordinary

rapidity and active research was instituted in a number of problems, in all of which Doctor Allen took a leading part. The work of the committee of the Ornithologists' Union on the conservation of bird life grew into such importance that it resulted in the birth of the National Association of Audubon Societies, of which Doctor Allen was one of the five organizers and in which he was an active director to the end. Among the other conservation work in which he took a prominent part was the formulation of the American Ornithologists' Union model bird law, which has been the foundation of much of the subsequent bird and game legislation in this country. This has been of incalculable value in conserving many forms of our wild life from extermination and was one of the elements leading to a practical activity in the conservation of wild life in the United States which is equaled nowhere else in the world.

Another committee of the Ornithologists' Union in which Doctor Allen took a part, that on the distribution and migration of North American birds, also outgrew the committee stage and became a division of the Department of Agriculture, later developing under the leadership of Dr. C. Hart Merriam into the Bureau of Biological Survey.

At the time the American Ornithologists' Union was organized zoölogical nomenclature was in a chaotic condition, which greatly increased the difficulties of scientific research. A committee on nomenclature was organized in which Doctor Allen's knowledge, clearness of vision and powers of logical reasoning made him a leading figure. This committee prepared the American Ornithologists' Union code of zoölogical nomenclature, which later became the basis of an international code, thus exerting world-wide influence on this phase of scientific research.

The early years of Doctor Allen's career were passed at what was then termed the Agassiz Museum but is now known as the Museum of Comparative Zoölogy, at Cambridge. In 1885 he became curator of birds and mammals in the American Museum of Natural History, where he had greater opportunities and his influence in the development of scientific research increased. For many years his attention had been devoted mainly to the study of birds, but during the last half of his life most of his time was given to mammals, in which he did notable work and held the same leadership that he had attained in ornithology.

At the time he came to the American Museum this new institution had practically no scientific study collections. Throughout the rest of his life he promoted many scientific expeditions to all parts of the world, and in addition encouraged the purchase of material, until the

study collections of the Museum today are among the most notable in the world, containing more than 200,000 specimens of birds and mammals, and with the great collections in other branches of biology give this institution high rank as one of the increasingly great centers of scientific research.

One of the greatest and most unselfish of the many services done for American science by Doctor Allen was his editorship first of the Nuttall Bulletin and then of The Auk, the journal of the American Ornithologists' Union, which he continued for a period of 35 years. This editorship was notable for the painstaking character of the work, especially in the innumerable reviews of ornithological publications, which had much influence in encouraging and developing young ornithologists and in promoting the increase of ornithological research. In addition, he also served for many years as editor of the Bulletin and other publications of the American Museum, placing them on the high plane which they have always maintained.

Doctor Allen continued throughout his life to devote the major part of his time to scientific research in birds and mammals, the extent and variety of which are shown by a bibliography almost unequalled in length by that of any other American scientist. Among these were several magnificent monographs, of which special mention may be made of those on "The American Bisons," "The History of North American Pinnipeds," and that on the musk oxen, which were masterly contributions to knowledge.

The early influence of Doctor Allen, and the small group of contemporary leaders with him, developed an appreciation of the meaning of geographic variation and its effect on the fauna and faunal relationship beyond anything of the kind previously known. Eventually the influence of this work spread and has profoundly affected the methods of scientific study of zoölogy both in America and in other parts of the world.

No account of Doctor Allen's career should omit reference to the extraordinary persistence and industry which continued throughout his life. He had a frail physique and suffered the serious handicap of more or less persistent ill health, and at intervals had physical breakdowns which threatened to end his career. He had within, however, the marvelous fire of a great spirit which ignored weakness of the flesh and steadfastly carried on his work under conditions which to many would have appeared impossible. He early learned to conserve his strength and for many years devoted himself steadily to office and

laboratory work, living an exceedingly simple life with almost no exercise beyond that had in his daily trips to and from his office. His friends often marveled at his being able to maintain himself in working condition under this routine, particularly when it was known that he was keeping persistently at his task of editing and writing, not only during office hours but evenings and Sundays, taking little or no recreation and pursuing this course year after year. Even then the extraordinary amount of his scientific output was made possible only by his ability to prepare his manuscript practically ready for publication in the first draft, the years of training in writing reviews and doing other editorial work undoubtedly having developed this most enviable facility.

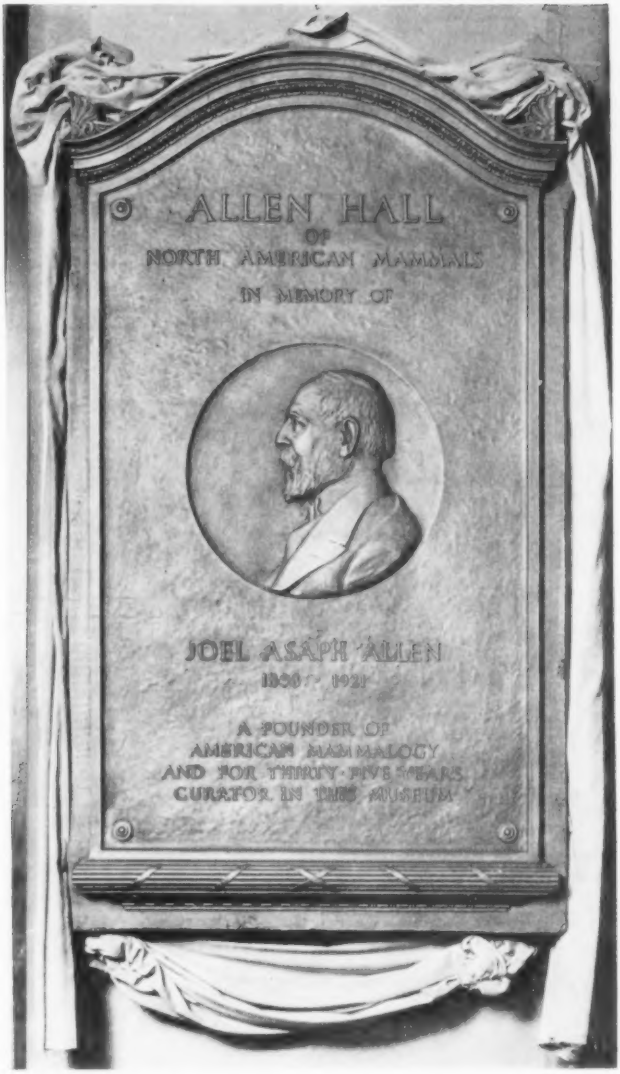
For many years Doctor Allen's career served as a great stimulus to young naturalists throughout the country. His clearness of insight and mental powers were backed with a strong will, which quickly impressed all who came in close contact with him. Among American scientific men few have been held in such general esteem and have been able to so influence their contemporaries and the development of the sciences in which they worked. His loss will long be felt not only among those who had the privilege of knowing him personally but by many workers who paid him the tribute of admiration and respect as a great scientific leader.

Biological Survey, Washington, D. C.

JOEL ASAPH ALLEN, 1838–1921

Courtesy of American Museum of Natural History

(Nelson: Dr. Joel Asaph Allen.)



MEMORIAL TABLET AT ENTRANCE TO ALLEN HALL OF NORTH AMERICAN MAMMALS

Unveiled at Fourth Annual Meeting of the American Society of Mammalogists, May 18, 1922. Courtesy of American Museum of Natural History.

(Nelson: Dr. Joel Asaph Allen.)

GENERAL NOTES

SOME RANDOM NOTES ON MAMMALS OF MINNESOTA

Lutreola vison. Mink.—In the fall of 1920, a farmer living on the Jefferson Highway between Elk River and Big Lake, Sherburne County, found a mink on this road that had evidently been killed by an auto. This was on a cement paved road.

Mephitis sp. Skunk.—There seems to be more or less disagreement as to the skunk's ability to discharge its scent under difficulty. I have taken and helped to take about fifty skunks from their dens in the last seven years. All were taken out alive and about one-half without their discharging any scent. There seems to be one, and only one, way to handle them safely; that is, grasp both hind feet and the tail firmly in one hand and pull them from the hole until the head appears, then grasp them around the neck. As long as they are held in this manner they cannot discharge scent, if the hind legs and tail are held straight out behind and a steady pull is maintained to prevent the back from "humping." They may then be placed in a sack and carried in the hand with the sack hanging free. Do not let them touch the ground or bump them. I have never had one try to bite, but would not take any chance, as I have known of their biting, and the bite is no joke.

Marmota monax rufescens. Woodchuck.—It seems to be not generally known that woodchucks climb trees. This was quite a surprise to me as I never considered this worthy of making notes on. The only time that I can give any definite information on is as follows: In the summer of 1917, while building fence, I saw a woodchuck fifty feet up in a basswood tree. I remember this because I threw my hammer at it and the the hammer lodged in a crotch of a limb on which the "chuck" was sitting and I had to climb the tree to get it.—BERNARD BAILEY, *Elk River, Minnesota*.

TREE-CLIMBING WOODCHUCKS

Mr. Harold St. John's article in the Journal of Mammalogy for November, on the tree-climbing woodchuck, came to me very much in the nature of a surprise. Years ago, as a boy, in Ontario County, New York, I repeatedly saw woodchucks "treed" by dogs, not infrequently to a height of at least ten feet, usually on the trunk of a tree of small diameter. Others with whom I used to discuss such experiences spoke of them as more or less commonplace. I had, therefore, assumed that while woodchucks were not arboreal by preference, they readily took refuge in small trees, when surprised at some distance from burrow or rock pile.— B. S. BOWDISH, *Demarest, N. J*.

THE SUBSPECIES OF WOODCHUCK IN VERMONT

In connection with an article by Harold St. John in the November, 1921, issue of the Journal of Mammalogy, there is pictured a woodchuck, photographed as it was climbing a tree, and under it is the name *Marmota monax preblorum*. The photograph was taken at Hartland, Vermont. Possibly this name was used because the subspecies of woodchuck mentioned is assigned to central Vermont

by A. H. Howell in his monograph, "Review of American Marmots," North American Fauna, No. 37, 1915.

A short time after the marmot "Fauna" appeared, I collected a number of woodchucks in Vermont and sent skins and skulls to Mr. Howell, who kindly examined them. He pronounced them all (seven, if I remember rightly) *Marmota monax rufescens* and remarked that some further revision of New England woodchucks would be necessary. In his review he writes that material from northern New England is lacking. The specimens sent Mr. Howell were from Rutland, from Ferrisburg, in the Champlain Valley, and two from Lunenburg on the east side of the state near the Canada line. There were none from Hartland and immediate vicinity but it is reasonable to suppose that the woodchucks there are the same as in Rutland, 35 miles away.—GEORGE L. KIRK, *Rutland, Vt.*

ANOTHER TREE-CLIMBING WOODCHUCK

The recent article by Mr. Harold St. John in the Journal of Mammalogy (II, No. 4, 1921, 207), concerning "A Tree-climbing Woodchuck" prompts me to relate my own experience with another tree-climbing individual in Iowa.

On July 2, 1914, while doing some field work to which I was assigned by the director of the Iowa Geological Survey three miles northwest of Waukon, Iowa, I disturbed an adult woodchuck (*Marmota monax monax*) which was feeding in an open pasture. Immediately the animal gave a sort of grunt and galloped toward a small white oak a short distance away. On arriving at the tree which was between eight and ten inches in diameter, it did not hestitate at all but climbed, without apparent difficulty, to the first limb which was at least eight feet above the ground. So great was my surprise that I stopped and stared at the woodchuck for a moment, then slowly walked toward the tree. The rodent partly lay across the lowermost limb eyeing me and breathing heavily after its exertion. After watching it for a few minutes, during which time it remained in the same position, I secured a heavy club and dispatched it by breaking its back so that the skull was left intact. The latter is preserved in the University Museum as accession no. 25697.

An examination of the greatly distended stomach revealed only clover, grass, and other vegetation. Unfortunately I did not secure a photograph of the animal. This species is very common in the driftless, hilly area of northeastern Iowa where it does considerable damage and as a consequence of which a vain effort is being made to control it through the bounty system.—DAYTON STONER, *University of Iowa, Iowa City, Iowa.*

WOODCHUCKS CLIMB TREES

Mr. Harold St. John, in the November, 1921, issue of the Journal of Mammalogy relates the case of the woodchuck, *Marmota monax preblorum*, climbing a tree and shows a photograph as evidence. He seems to think that such an occasion is unique and farther states that he had difficulty in convincing people of the fact.

I can assure Mr. St. John that I have frequently seen woodchucks climb trees. Two or three incidents stand out vividly. When a boy on the farm at home I on two occasions stoned woodchucks out of trees where some farm dogs had chased them. As I recall, both of these chucks were small and immature, but a few years

ago I saw a very large one in the top of a black walnut, where it had also taken refuge from the dogs. While such cases may be uncommon, no doubt there are many other observers who have seen woodchucks climb trees.—CLEVELAND P. HICKMAN, *West Virginia University, Morgantown, W. Va.*

MORE TREE-CLIMBING WOODCHUCKS

The note in the November Journal of Mammalogy on a Tree-Climbing Wood-Chuck by Mr. Harold St. John recalls an experience of the past summer. I was engaged in listing the birds of the new Allegany State Park, Cattaraugus County, New York, when one day, July 16, 1921, I came upon a woodchuck (*Marmota monax preblorum*) about ten feet up in a dogwood tree. I had not seen the animal climb there, and do not know whether it climbed there because of my approach or was already there when I approached. The tree was about six inches in diameter, and leaned somewhat to the south which was the downhill side. This tree was in the midst of a large sized patch of woodland, and a considerable distance from any open country. I tossed a few sticks at the animal expecting it to jump or run down the tree, but while it seemed frightened, it seemed also unwilling to leave the tree.

After this experience I asked others who lived in that vicinity the question "Have you ever seen a woodchuck climb a tree"? Almost invariably I got the answer "Yes," with a statement that they often did it to escape enemies. Returning to my home in southern Connecticut I tried the question on people in that vicinity with the answer that they had never heard of such a thing, most of them adding that woodchucks seldom were found near trees. From this experience I concluded that the tree-climbing habit in woodchucks is something that is decidedly local, belonging chiefly to animals that live in wooded regions, rather than to those that live in open country.—ARETAS A. SAUNDERS, *Fairfield, Conn.*

THE TREE-CLIMBING HABITS OF WOODCHUCKS

In the Journal of Mammalogy for November, 1921, there is a photograph and an excellent description of a "Tree-Climbing Woodchuck." I did not know that it was considered unusual for woodchucks to climb trees, but some of my friends think it is.

As a boy and young man, I lived in the hilly region of southwestern Pennsylvania where woodchucks were very common, often becoming a nuisance. I now recall five instances of woodchucks climbing trees. They were all put up by dogs and I observed them in every case. The first live woodchuck that I ever saw was one that a big dog ran up a butternut tree that grew along the border of a woods. The chuck was not full grown, but it went to a height of about 15 feet. My oldest brother climbed the tree and shook it down. A few years later, I was one day walking with my father through a woods containing almost a pure stand of white oak trees. Our dog got between a woodchuck and its burrow and chased it up one of the trees. This oak was nearly two feet in diameter with no branches for nearly 30 feet. The chuck continued to the first stopping place, a large lateral branch or open fork. My father threw two or three stones at it, but failed to hit it. The animal kept looking down at the barking dog and as it did so, it began to shake and wobble and finally tumbled to the ground. This would indicate, to me, that woodchucks are not familiar with high climbing. This one

climbed higher than any other that came under my observation. When grown to manhood, I often went by the tree and estimated the height to which this woodchuck climbed to be at least 30 feet.

Another incident may be of interest. I had gone home from college to spend my vacation with my father. One night about 10 p.m. we heard two dogs in the the woods barking as though they had something "treed." My brother and I went to investigate the matter and found the dogs against a steep hillside barking up a dogwood tree. In a fork about eight feet from the ground was a large woodchuck. The dogs had probably treed it sometime during the day and were now laying siege to it. They had the bark peeled from the tree and were doing their best to get the chuck down.

The last time that I saw a woodchuck up a tree was only a few years ago. I had spent the day in the woods collecting plants, and was returning home about sunset. On hearing our dog bark I went to the place and found a half grown woodchuck up a shagbark hickory tree. It was eight or ten feet from the ground and had secured itself back of one of the stiff, shaggy plates of the bark. From all appearances the dog had chased it up the tree sometime earlier in the day.

Where the burrows of woodchucks are along fences, it is quite a common sight to see the animals climbing the posts or rails, perhaps to sun themselves or to make observations. To avoid dogs they will climb trees if they cannot reach their burrows, or escape by some other means.—Oliver P. Medsger, *Arlington, New Jersey.*

CONNECTICUT WOODCHUCK CLIMBS A TREE

In connection with the note on a tree-climbing woodchuck, vol. 2, p. 207, I write to say that my brother, F. C. White, saw a woodchuck climb a tree because frightened by his dog. He subsequently pointed out to me the limb to which the animal had clambered; it was about six feet up from the ground. This was at Hartford, Connecticut.—Francis Beach White, *Concord, New Hampshire.*

NOTES ON A FEW MAMMALS AT MISSOULA, MONTANA, 1917–1918

Thomomys fuscus fuscus. Pocket gopher.—Mounds are abundant on the bunchgrass of the Bitterroot Valley and over the open slopes of the mountains; a few occur also among the cottonwoods. June 3, 1918, a few minutes past 4 p.m., a half-grown male was found running on the University campus lawn.

Citellus columbianus. Ground-squirrel.—Locally called "gopher." Abundant on the bunchgrass; common in yellow pines; and numerous in the chaparral brush on the mountain sides. In 1918 it was first seen April 10. In 13 adult females taken between May 4 and 16 on the slopes of Mount Sentinel for use in the zoological laboratory, embryos were found as follows: one with 3 embryos 22 mm. in length, as they lay rolled in the fetal membranes; one with 3 embryos 20 mm.; one with 3 embryos 16 mm.; one with 4 embryos 13 mm.; three with 4 embryos each, too small to measure.

Eutamias sp. Chipmunk.—Numerous in cottonwoods, in brush along the canyon streams, in yellow pines, and abundant on talus slopes. In 1917 last seen November 4, and in 1918 first noted April 7. May 19 one was noted eating dandelion seeds while seated on a rock pile at the edge of the cottonwood forest along Rattlesnake Creek. He would cut off a ripe head and then seating himself on a rock would

cut away one side of the head near the base and eat the seeds. He was quite wasteful, spilling many of the seeds on the ground. He apparently attempted to eat only the seeds, but I could not be sure whether or not he cut off the seed plumes, though I think he did.

Sciurus hudsonicus richardsoni. Richardson squirrel.—Few in yellow pines and in mixed yellow pines and Douglas spruces.

Castor canadensis canadensis. Beaver.—April 14, 1918, fresh cuttings were noted on cottonwoods along Rattlesnake Creek.

Lepus bairdii bairdii. Rocky Mountain snowshoe hare.—June 9, 1918, one was seen in Douglas spruce-western larch forest near Lo-lo Hot Springs.

Sylvilagus nuttallii nuttallii. Washington cottontail.—One was seen October 21, 1917, in brush along Rattlesnake Creek.—LEE R. DICE, *Museum of Zoology, University of Michigan, Ann Arbor, Mich.*

SILK BUFFALO ROBES

In the Journal for August, 1921, Mr. E. R. Warren of Colorado Springs, Colorado, asked for information in regard to a "silk buffalo" robe. Recently, while glancing through Volume 1 of Ernest Thompson Seton's "Life Histories of Northern Animals," I found the following: p. 250: "The 'Beaver robe' was a rich brown with very fine fur, of these not more than one in ten thousand was found." P. 283, quoted by Seton from C. E. Denny, Forest and Stream, May, 8, 1897, p 362: "The robe was nearly always of a cow, very fine and very light. Many explanations were given by hunters for this peculiar coat, and the right one was no doubt that given by Montana Indians—that it was caused by the constant licking of many animals in the herd, to which some motherless calf belonged, it having become the pet of the band, the animals testifying their liking in that manner." Thinking this may interest other readers of the Journal, I am sending it on.—K. F. BASCOM, *Dept. of Zoology, University of Chicago, Chicago, Ill.*

RECENT LITERATURE

Grinnell, Joseph. A GEOGRAPHICAL STUDY OF THE KANGAROO RATS OF CALIFORNIA. University of California Publications in Zoology, vol. 24, no. 1, pp. 1–124, pls. 1–7, text figures 1–24. June 17, 1922.

Grinnell's "Geographical Study of the Kangaroo Rats of California" presented with a wealth of pertinent detail is not only a valuable contribution to our knowledge of an exceedingly interesting and imperfectly known group of rodents, but has an important bearing in a wider field as well. The main purpose of the work as stated by the author has been "to ascertain the degree of correlation which exists between speciation and geography and environment," and perhaps no better group of mammals, owing to its plasticity, or a better area, due to highly diversified environmental conditions, could have been chosen.

The author's conclusions are based upon a study of 2,834 specimens from California, of which 2,212 skins with skulls, representing 213 localities, are in the Museum of Vertebrate Zoology, University of California. Four hundred and nine specimens of kangaroo rats in the collection of the Biological Survey, United States Department of Agriculture, representing species and localities deemed of special importance by the author, were shipped from Washington, D. C., and material was made available by other institutions.

Thirty-three species and subspecies of kangaroo rats are recognized as ranging within the State of California, "as many forms as occur all told outside of this State and at the same time do not reach into it." These are assigned to the Heermanni, Ordii, Merriami, Agilis, Microps, and Deserti groups, the group names being those of typical included species.

Until Doctor Grinnell began his work upon the kangaroo rats, three generally accepted genera, *Dipodomys*, *Perodipus*, and *Microdipodops*, were assigned to the subfamily Dipodomyinae. The generic separation of *Dipodomys* and *Perodipus* rested upon the supposed constancy of a differential number of complete digits on the hind foot. The author, however, has made the important discovery that in parts of the distribution area of *Dipodomys heermanni* the small rudimentary first toe on the hind foot may be present or absent. The detection of positive evidence of intergradation in this character within a limited area between forms obviously not otherwise materially different is of special interest, in view of the remarkable constancy with which a fixed number of digits (4 or 5) on this foot is maintained in all of the species throughout the remainder of the wide range of the subfamily from the Valley of Mexico to southern Washington and Montana.[1] All of the species heretofore assigned to the five-toed genus *Perodipus* are therefore transferred to the genus *Dipodomys*. No reason is noted for the omission of the genus *Microdipodops*, currently regarded as a true kangaroo rat and represented in California by one species, the inclusion of which would have completed the treatment of the subfamily within the state.

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[1] This condition seems somewhat analogous to that obtaining in certain squirrels, and in bats of the genera *Artibeus* and *Myotis*. The number of premolars constant in most of the included species is variable, owing to obsolescence in several, and the tooth formula therefore becomes unreliable as a generic character.

The apparent effect of climate upon the color and texture of the pelage in kangaroo rats is pointed out, closely paralleling the findings of revisers of other groups of rodents with geographic ranges embracing both the humid Pacific coast region and the arid interior. Examples of nearly parallel conditions are found in the wood rats—*Neotoma intermedia intermedia* of the western slope of the mountains, and *Neotoma intermedia desertorum* of southeastern California; and *Neotoma cinerea cinerea* typical of the Great Basin and its darker coastal counterparts *Neotoma cinerea occidentalis* and *Neotoma cinerea fusca*, and in others which may be readily cited.

Consideration of habitats, says the author, "in connection with size of ear brings out unmistakably the correlation of small pinna with open type of habitat, and in the other direction, of large pinna with a chaparral type of habitat. The same tendencies are to be observed in *Peromyscus* and *Perognathus*." While this may appear to be true in some of the California forms of these genera, it should be noted that the kangaroo rats with the largest and the smallest ears, *Dipodomys elephantinus* and *Dipodomys microps*, are assigned habitats as species wholly within chaparral, and more open types of country, respectively. The large-eared California pocket mouse, *Perognathus femoralis*, which the author may have in mind, is another chaparral-loving species with a very restricted known range. Some species of *Peromyscus* and of mammals in general inhabiting open types of country have very large ears. Admitting that certain large-eared species of kangaroo rats are associated in California with more brushy habitats than are usual in the general group, such generalizations would seem better based upon studies of more widely ranging species subdividing into geographic races and inhabiting cover of varying density.

In the discussion of distributional considerations the conclusion is reached that "as regards the species and subspecies of kangaroo rats in California, humidity is of minor importance as a barrier to extension of range as compared with unfavorable temperature and bodies or streams of water." The probable evolution of ranges is traced. Owing to the aversion of *Dipodomys* for water, continuous bodies of this element are regarded as effective barriers, but *Dipodomys deserti* and *Dipodomys merriami* occur on both sides of the lower Colorado River where shifting river channels transferring tracts of inhabited bottom land from one side to the other have doubtless given access to the opposite side. The transference of individuals, postulated by the author, would be especially likely to occur during such extensive changes in the course of the stream as took place fifteen years ago, when through the agency of man in cutting a narrow irrigation ditch, the great river was unintentionally turned into Salton Sea whence it was rediverted with the greatest difficulty at the end of about a year; and the course taken by the main stream since this diversion is in places many miles west of that formerly followed.

In the formal treatment of species there are no generalized accounts of species as aggregations of subspecies, the author passing directly to a consideration of the component parts. The first species receiving attention is *Dipodomys heermanni*, and in treating its parts, instead of following a common custom among revisers of taking up first the typical subspecies, he begins with the widely ranging northern form, *Dipodomys h. californicus*, and proceeds southward, the typical form being third in the series. On reaching *Dipodomys agilis*, however, the typical

form is the first treated. The accounts include the principal synonymy, a "diagnosis," discussion of relationships, and full paragraphs under several other headings—the type locality and distribution, together with localities and numbers of specimens examined, being placed at the end. Measurements, including "ear from crown," when available, are given under each species, and in many instances the weights in grams, a valuable feature.

In regard to methods of measuring the author states that total length given "is the distance (with body and tail straightened out) from the tip of the nose to the tip of the last caudal vertebra, taken usually after skinning. If this measurement is taken in kangaroo rats before skinning, there is a chance of error because the skin sometimes slips backward some millimeters free from the actual tip of the vertebral series. Tail vertebrae is length of tail alone, from a point on upper side at base where tail can be bent at right angles to back, to tip (as just designated)." It seems to the reviewer that such a method of measuring specimens is an attempt to attain a degree of accuracy impracticable in general work. The most valuable field measurements, on the whole, are those taken by as nearly standardized methods as possible adopted by preparators in general, because these will be fairly comparable, while variations from the general standard may be misleading in application without the constant repetition of explanations. Measurements taken by different collectors, whether before or after skinning, vary with the tension exerted or with other individual peculiarities of method, and they vary, moreover, with the degree of relaxation of the body of the animal. Tables of measurements usually reveal considerable range of individual variation in total length and length of tail in animals of comparable age, and the average is obviously governed by the relative number of large or small examples chosen. These measurements must therefore usually be regarded as approximations only, which for most practical purposes should be taken before skinning, the body and tail being carefully straightened or extended to the natural limit, but not stretched.

The taxonomic treatment of a group, especially the number of forms recognized, their status as species or subspecies, and the distribution area assigned to each is likely to vary always with the varying standards set up by different workers. Perhaps no two would arrive at exactly the same conclusions. Local variants are of great interest to the close student of speciation and geographic distribution, and the current tendency is toward greater refinement in the process of "splitting," in such classes as mammals and birds at least, until the forms, if accepted, become so numerous and their ranges so restricted that the determination of new accessions of specimens is accomplished only with the greatest difficulty. The tendency to set up an excessive number of local forms is apt to be marked in faunal papers, in which the irregular, minor geographic variations presented by many widely ranging species are appraised at more than their true value. The reviser of the genus has the advantage of the wider viewpoint of the group as a whole.

In so diversified a region as California the desirability and practical utility of recognizing a considerable number of well-marked geographic races of kangaroo rats, some of which have very restricted ranges, is freely granted. But in the opinion of the reviewer the author in some of his conclusions accords undue importance to characters ascribed to certain forms, examples of some of which are cited. "*Dipodomys levipes*," orginally described as a subspecies of "*Perodipus microps*,"

is elevated to full specific rank, although it "agrees with *microps* in important features of the cranium" and the "two species are similar in their rather dark type of coloration, as well as in most other external features." The differential characters mentioned are the larger size of *levipes* and details subject to considerable variation. The author is usually careful and generally accurate in his descriptions, but the statement that the mastoid bullæ in *levipes* are "fully twice the volume of those in *microps*" is inexact. This is a very variable character, as shown by the examination of paratypes of the two. The mastoid bullæ of the larger examples of *microps* closely approach or about equal those of the smaller examples of *levipes*. Probably a study of the complete range of the *levipes* type of animal across Nevada to Utah and northward to Oregon would have led the author to adopt their original status as subspecies, not very strongly marked at best.

The "Heermanni Group" is made to include four distinct species, *Dipodomys panamintinus*, *D. leucogenys*, *D. mohavensis*, and *D. stephensi*, with very limited, contiguous, or only slightly separated ranges in a region of general physiographic conformity, mainly the desert basal slopes of the mountains in southeastern California. These all agree in the possession of a salient character indicating very close relationship, the decided expansion of the maxillary arches, which at once distinguishes them from externally similar species of the genus which frequently occur in the same localities. The forms "*mohavensis*" and "*leucogenys*," described as new species, vary considerably, but specimens from the type localities are slightly paler than topotypes of *panamintinus* and present slight cranial differences, mainly size, the kind of characters we learn by analogy to regard as of not more than subspecific value. Their combined ranges half encircle that of *panamintinus*, and other geographical considerations indicate the expediency of reducing them to subspecies, or reuniting all under a single name. In cranial details *D. stephensi* presents a rather slight departure from the *panamintinus-leucogenys-mohavensis* type in that the mastoid bullæ are decidedly more inflated and there is a correlated reduction in width of the supraoccipital and interparietal, a condition not uncommon elsewhere in the genus. This form stands somewhat apart and should, perhaps for the present, be accorded specific rank, but as the characters are those usually found to be of subspecific value, intergradation may reasonably be expected.

Two subspecies, *D. nitratoides nitratoides* and *D. n. brevinasus* are assigned to very limited ranges known to be broadly confluent in the bottom of the southern end of the San Joaquin Valley, an area presenting little diversity in faunal complexion. The characters pointed out are variable and these forms are not regarded by the reviewer as satisfactorily separable. Other cases might be mentioned, but these among the more extreme examples are indicative of the general method of treatment.

While Doctor Grinnell may not be followed in all of his conclusions concerning speciation, the severest criticism being that this part of the work is over-done, he has succeeded admirably in the main purpose as announced by him at the outset; but the degree of correlation between speciation and geography and environment can be satisfactorily ascertained without the recognition of an unwieldy number of forms. His elucidation of some complicated relationships will greatly facilitate the revision of the genus *Dipodomys* as a whole.

—*E. A. Goldman.*

Gregory, William K. THE ORIGIN AND EVOLUTION OF THE HUMAN DENTITION. Baltimore: Williams & Wilkins Co., pp. i–xviii, 1–548, including plates. 1922.

The Origin and Evolution of the Human Dentition is primarily a review covering a wide field of research, carried over a number of years, both by the author and other authorities. It therefore constitutes an authoritative and comprehensive treatise in which the author has brought together and presented in a masterful way a vast fund of highly important and valuable information. Incidentally, many important controversial questions have been discussed. The author doubtless will not be followed by some in all his deductions and conclusions regarding these questions, yet it cannot be denied that they have been frankly and fairly argued. Doctor Gregory has presented both sides of all controversial points in his usual fair-minded manner, and has handled the facts in a way to inspire the confidence of the reader in his ability to observe clearly and to interpret intelligently. Regardless, therefore, of what may be the verdict of other authorities in accepting or rejecting some of the theories defended by its author, this book must stand as a most valuable and convenient reference work on the subjects treated therein.

The book is splendidly illustrated with 353, for the most part, accurately executed line drawings and half-tone figures. Although most of these have appeared in various earlier publications, either of the same author or those of others, their reproduction here adds immeasurably to the value of the work.

Lack of space does not admit a complete or even adequate partial review of this important work, hence little more is attempted here than to give a very general outline of the subject matter contained in it.

The book, which contains more than 500 pages, consists of five major parts which were first published in five successive numbers of the Journal of Dental Research, to which have been added an important preface and several corrections of errors which crept into the original publications.

Part I deals principally with the earliest stages in the development of teeth in the vertebrates and with the principal steps in evolution leading up to the early mammalian types of dentition. It includes an exhaustive review of the general theory of tooth-cusp development in the mammals, in which the author upholds in part the Cope-Osborn tritubercuiy theory, and accepts in general but not in its entirety the "premolar-analogy" theory as defended by Wortman and Gidley. In this connection he has introduced a hypothesis of his own, which is mentioned here only because of the very vital bearing it has on a very fundamentally important deduction postulated by the author in its assumption, namely, that the type of upper molar in which the paracone and metacone are fused, or but slightly separated, and set well inward from the buccal side of the tooth crown (such as *Centetes*, *Potamogale*, *Solenodon*, etc.) is nearest to the basic type of dentition from which have been derived all the more modern forms of tooth structure of the placentals and marsupials. This is based on an assumption denied by Gidley (1906) that the main internal cusp in the upper molars of such forms as *Dryolestes* of the Upper Jurassic is not homologous with the corresponding cusp in modern mammals, but that it represents the primitive reptilian cone, which, through the inward building of a cingulum cusp (the "protocone") finally became the paracone-metacone of modern mammals. There is not space to discuss this important question here, but it may be stated on the authority of the present re-

viewer, who has critically studied these so-called Jurassic mammals, that Gregory's theory has been based largely, at least, on a wholly erroneous conception of the true structure of the upper molars of *Dryolestes*. Happily, however, the truth or falsity of Gregory's deductions in this regard do not materially affect the broader proposition of the derivation of modern mammalian molar teeth from the ancient tritubercular-tuberculosectorial type of teeth.

Part II is primarily an introduction to the study of the evolution of the teeth in the Primates and deals at length with the origin and early development of this great order, while the taxonomic position of its earliest known representatives is discussed. The author here reaffirms his former classification of the Primates in which he placed the Eocene notharctids definitely in the "Lemuroides" as opposed to Wortman's disposition of this group, which the latter concluded were true anthropoids, but no new evidence is added in support of this affirmation. In this part also are presented the principal steps leading from the primitive mammalian tooth structure to the primitive primate dentition.

Part III is devoted almost entirely to a study of the dental structure and other anatomical modifications of the so-called large-eyed, short-jawed primates, including the Eocene members of the Tarsioidea, and the South American monkeys, in respect to the possible origin of their living representatives. In this connection the author has made a special study of the various groups of South American monkeys with reference to their possible bearing on the problem of the origin of man.

The same general discussion is continued in Part IV, which deals principally with Old World monkeys and apes. In this section are reviewed and discussed the anthropoids of the Miocene and Pliocene and their supposed modern descendants, especially in their more immediate relation to the orgin of the human race and the development of the human dentition. It is concluded from these studies that man "has been derived from the *Dryopithecus* group of the Simiidæ in the late Tertiary."

In Part V the author discusses fully the later stages in the evolution of the human teeth and considers more in detail the dental characters of extinct races of men, comparing them critically with those of the anthropoid apes. This is followed by a conspectus of the species and chief races of the Hominidæ. At the end of Part V the author concludes with a final summary of the whole work in which he outlines "twenty-six stages in the ascent of man and in the evolution of the human dentition."

—*J. W. Gidley.*

Underwood, William Lyman. WILD BROTHER. Boston; The Atlantic Monthly Press. 12mo, pp. i–xi, 1–140, 39 plates. 1921.

On January 23, 1903, in the woods of northern Maine a cook from a logging camp shot a black bear in a den under a large dead pine tree, and by this act made orphan a naked, week-old cub. This little cub becomes "Bruno," the Wild Brother, of Doctor Underwood's story. We read how he is adopted by a kind-hearted woman and nursed at her breast as foster brother to her little girl; and how he becomes a burden to his foster parents and is taken to the home of Professor Underwood at Belmont. And then his behavior and pranks at Belmont are revealed to us in a most interesting manner. For example, we read: "..... Down in the garden one day I found a large fat toad, and when Bruno was at lunch

I placed the warty creature on the ground beside the saucer from which the cub was taking his food. Being quite hungry, at first he paid no attention to the intruder; but presently, as the saucer became empty, he caught sight of his curious visitor. With a jerk he raised his head, and for a moment, without moving a muscle, gazed in astonishment and with some misgiving at the strange monstrosity in front of him. His natural curiosity, however, soon overcame his doubtful frame of mind; he was a born investigator and this thing must be looked into. Very cautiously he reached forward his paw and ever so gently he touched the curious thing on the back.

The toad did as toads usually do when tickled from behind. It hopped, and with such force that it went quite over the saucer. Simultaneously the bear stood erect. He had a puzzled look of amazement and dismay on his hairy visage; he appeared to be utterly overcome with astonishment. It didn't seem reasonable that an insignificant misshapen creature like that could, with no apparent effort, cover so much ground in one leap. Bruno's paws hung inertly in front of him and his tongue lolled stupidly from his mouth. His breath came in short explosive gasps.

Suddenly the toad hopped again, and with a *'Whoof, whoof, whoof,'* away ran the bear round the corner and out of sight. No more toads for him; one was enough for a lifetime!"

The book ranks among the best nature stories published in recent years. It is trustworthy, unexaggerated, and well written. The press work is excellent, the paper of good quality, typography clear, illustrations numerous and attractive, and the binding neat and durable. It is a book that might well be read by anyone interested in nature, mammalian behavior, or good literature.

—*Hartley H. T. Jackson.*

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